SCIENCE

FRIDAY, NOVEMBER 11, 1910

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THE POSITION OF THE CHEMIST IN THE COMMONWEALTH[1]

THE honor conferred upon the chairman by his associates carries with it a responsibility that is not to be regarded lightly. Aside from the duties, which are well defined, of looking after the welfare of the section, presiding over its meetings, which are to be made as interesting, attractive and instructive as possible, the responsibility presents an opportunity. The present chairman of this, the first section of the society to be organized, and the largest, a section containing over ten per cent. of the entire membership and twice as many members as the parent society claimed when he first began enjoying its influence and privileges, welcomes the opportunity with pleasure. I shall give the section my best service.

Among other things my conception of the office of chairman calls for a frank presentation of such problems, general or local, which appear needful of solution and may be best solved by democratic discussion. Every member of the society should give those matters which have to do with the society's interests the most careful consideration and such subjects should be thoroughly discussed by every section that the course followed by its councilors may be in a measure representative of that section's opinion. I furthermore feel that members of the council from sections should give an accounting of their service that the section may decide if it wishes to

[1] Address of the chairman of the New York Section of the American Chemical Society, delivered October 7, 1910.

continue such representation. On such a basis, and such a basis alone, do I think local representation in the council should be placed. The New York Section by its large representation in the council, honorary and elective, must have great influence in solving any problems to the society.

I wish to ask your attention to two matters this evening. The first has to do with the American Chemical Society in general.

The most serious problem that the American Chemical Society is now facing is that of increasing its efficiency. At present the society maintains five different offices in places as far separated as New Hampshire, New York, Ohio and Illinois, with inadequate salary and other accounts at each place. No criticism of any individual or any one of these offices is intended or must be inferred. We are grateful for the excellent services generously rendered, but it is not good business. I would substitute a concentration of organized efficiency for a segregated unity of intent. This proposed centralization of labor may be accomplished without destroying the democratic representation and has amply good precedent; and it will be made the easier of accomplishment by the early completion of our splendid new club house, the American Chemists' Home. There suitable office space may be secured for the right man, who should receive a substantial honorarium and be provided with associates and a sufficient clerical force to care for the library, the society's publications, and to quickly dispatch all matters of business. The desirability of this will become more apparent as soon as the entire library of the Chemical Society may be placed upon the shelves, but especially when the circulating Perkin and Chandler libraries become available for the chemists throughout the country.

Second, as for the New York Section in particular. The more I study, in my professorial capacity, the social and economic conditions of this great city—this the second city of the world, having within its 327 square miles more people than the states of Massachusetts, Maine and Vermont combined, with their 47,000 square miles; having within its actual city limits more people than were in the entire United States when our government took shape—the more convinced I am that New York's greatest material need at present is the chemist. To be sure, one who keeps posted knows that Chandler worked valiantly on the board of health for eleven years, that Metz sought to put the purchasing power of the city's money on a par with that of any private corporation, that Lederle is decreasing the death rate in our municipality; but these are sporadic cases and the influence exerted, however valuable and striking at the time, is more or less evanescent by virtue of the method of appointment and limiting term of office. To be sure, an expert chemist controls the quality of illuminating and fuel gas in the city. A chemist, nominated by this section, sits as a member of the municipal explosives commission. But, it seems strange to me that a municipal sewerage commission should be in existence with no chemist as a member. The sewage problem confronting us is undoubtedly a most serious one, and one which we shall soon have to solve at an expense even greater than the cost of the magnificent new water system that is now being installed. Advice obtained from an adequate soil survey would help relieve the distressing conditions of our parks at present. It will be cruel if the public service commission allows the construction of any more subways without stipulating that the trains going in opposite directions be placed in separate tubes or tunnels. The various devices for im-

proving the ventilation of the subways, which we observe being tried out from time to time, are at best mere palliatives and not actual preventives. No chemist is a member of this commission. Not long ago a vacancy occurred in a most important commission due to the resignation of the chemist member of the board. A petition signed by half a hundred prominent chemists was sent to the governor requesting the appointment of a chemist who was recognized as one of the world's authorities and regarded the most eminent among his colleagues in that particular field. A courteous acknowledgment was returned, but the private secretary received the appointment.

These matters are not referred to in a spirit of peevish criticism, and are not true of New York alone, but are mentioned in order to emphasize the importance of the part the chemists should play in the public weal and how that happiness can be enhanced. For it is a fact that the chemist does not measure up to his full value and importance in the summation of municipal and communal affairs. We can not always blame some political party in this matter. Sometimes they are not guilty, and even if they were, I feel that it is not right for us to shift the blame. Rather let us assume the entire responsibility, for, in truth, we, the chemists, are guilty.

Now, how are we to remedy this state of affairs? Can it be remedied? To the latter, I say "yes." In answer to the former question, I will say that conditions can be helped, not fundamentally, perhaps, but specifically, by the Section taking up some one matter at a time—for example, the establishment of a dignified advisory scientific commission, untrammeled by political, official, religious or social associations, which shall hold itself in readiness for consideration of every serious problem presented to it, and exert such a power in public opinion that its advice must be taken. I will go further; if the Section take this matter up, and, having settled upon a policy, present it with sufficient strength to the proper authorities, it is not improbable that a clause establishing such a commission may be inserted in a revised charter of the city. The study of and a frank discussion of local problems must become the policy of the Section, however, if anything of real value is to be accomplished, for chairmen come and chairmen go, but a principle lives on. And this principle shall be established.

We can strike at the root of the failure of the chemist to occupy his proper place in the body politic through our educational institutions. In this, the Section can be helpful in advising with the various teachers. Twenty years' experience has convinced me that no man or woman, whatever may be his or her calling, has a right to an academic degree unless the training laid out for such an acquirement involves one course in chemistry. In that general course the relation of the individual to the community, the chemist and the commonwealth as it were, should be brought out and hammered home. In this manner a few generations of graduates, not themselves chemists, but men of education in fact, who have learned the value of the chemist in the community, will make the principle felt. For college men will more than ever rule our country. In the meantime, the universities and technical schools must see to it that their graduate chemists, chemical engineers or engineer-chemists, have not only acquired superior professional proficiency, but a broad culture which fits them to deal with these great problems with tactful force. We may be but tillers of the soil now, but the harvest to be reaped will repay the labor spent.

CHARLES BASKERVILLE
THE COLLEGE OF THE CITY OF NEW YORK

INTERNATIONAL CONGRESSES[1]

The pursuit of science has from early times developed friendships among men of the most varied nationalities. These friendships have persisted even in times of war between their nations. Intercourse has been promoted by private correspondence and by means of periodicals. With improved methods of transportation the desire of more personal intimacy was gratified, and the value of harmony and cooperation recognized.

The necessity of international congresses appears to have been first appreciated by chemists. A purely international congress of chemists was planned in 1859 for the spring of 1860, but later it was decided to fix the meeting at Carlsruhe on the third of September in the same year. Letters of invitation were addressed to eminent chemists, and the response was encouraging. The meeting was attended by one hundred and forty chemists from all parts of Europe and lasted for three days. Most of the time was devoted to a discussion having reference to the best method of expressing the composition of chemical substances in the symbolic notation, and the debate on this point was very animated. (Appendix I.) The hope was generally expressed that this meeting would not be the last. However, no more congresses of chemistry of an international character were held until 1889. Nevertheless, the value of these was recognized and certain efforts were made to revive the movement of 1859 at frequent intervals; but the international conventions of chemists were limited to a discussion of the exhibits showing the development of chemical productions at the international expositions of Paris (1867, 1878, 1889), Moscow (1872), Vienna (1873), Wilna (1873), Philadelphia (1876), Düsseldorf (1880) and Milan (1881). Quite a number of chemists usually attended these exhibitions as members of juries of awards as well as through personal interest, and it appears that they served to induce informal assemblage and exchange of opinion. However, with the rapid development of our science and its applications, it soon became apparent that the discussion of problems could be advantageously transacted in convention as well as in journals, especially since the personal exchange of views in informal and social manner had been found by local and national (chemical societies) conventions to be particularly beneficial.

On July 30, 1889, the International Congress of Chemistry was opened in Paris by Berthelot, who exposed the objects of the congress as follows:

> Theories are not to be considered, but only practical questions, such as relate to analytical methods and nomenclature. The last urgently needs revision and improvement. The system hitherto followed has become insufficient. So many new compounds have been discovered that they are bursting through the frames formerly intended, and thought wide enough, to contain them. . . . We can not keep on adding syllables and forming endless names for new combinations. A new and clearer system is absolutely necessary, with lines broad enough to last for some time at least.

In object, then, this congress was similar to the one at Carlsruhe. More important matters were discussed, however, and views of an influential nature were expressed on the testing and analysis of chemical products, particularly organic bodies, alimentary substances and pharmaceutical preparations.

The necessity of international congresses of science having become appreciated, principally owing to the recognition of the value of international associations among men of science, since such assemblages were found to serve as a medium for the fruitful

[1] Read before the New York Section of the American Chemical Society, October 7, 1910.

interchange of views, these organizations have increased to a large number (Appendix II.)—to such an extent, in fact, that some begin to overlap, and the fear has been expressed that varied attempts to advance knowledge by organization may result in discouraging individual effort. For the obviation of conflict, it has been suggested that the International Association of Academies have the ultimate control of every new international undertaking. In purely scientific organizations of an international character this may be desirable, but the congresses of applied science have demonstrated their value and will continue to exist without ulterior control—although cooperation is expedient—since their fields are sufficiently restricted and interdependent, that fine academic discrimination is not required.

Schuster[2] has distinguished three types of international organizations. According to him, the first aims merely at collecting information; the second is intended to fix fundamental units or to initiate agreements on matters in which uniformity is desired; while by the third type of organization a more direct advance of knowledge is aimed at and research is conducted according to a combined scheme. We may say in general, however, that an international organization does not entirely come within any single one of these divisions, but it is of value to classify the associations according to their main purpose.

In 1893, the World's Congress Auxiliary and the American Chemical Society united in calling a meeting of the chemists of the world to attend a general chemical congress. This was held in connection with the Columbian Exposition in Chicago, and about two hundred attended. The efforts made by the organizing committee were followed with most gratifying success, and the chairman, H. W. Wiley, suggested the establishment of a triennial international congress of chemistry to meet at various centers. This recommendation was taken under consideration and initiated a movement which resulted in the formation of a permanent congress. A committee representing the American Chemical Society requested the chemical societies of the world to appoint similar committees of conference, in order to consider whether it was desirable and practicable to organize a series of international chemical congresses, "in which the chemists of the various nations can regularly meet together for a discussion of questions of common interest." How favorable the response was, will be apparent from what follows.

The first International Congress of Applied Chemistry was held at Brussels, under the patronage of the Belgian government, in 1894. It was divided into four sections. The first of these dealt with sugar chemistry, and here analytical questions were discussed. In the second section, agricultural chemistry, attention was paid especially to the determination of phosphoric acid. Section III., food and public hygiene, was rather general in its aims, but the congress endeavored to settle the minima of impurity allowable in distilled liquors and the best process for fixing the melting points of fats. The fourth section dealt with biological chemistry. At this congress it was decided to hold the meetings biennially and Paris was selected for the reunion in 1896.

The second International Congress of Applied Chemistry was opened under the patronage of the French government, and lasted ten days. To promote the interests of the congress committees had been organized in most countries, and through the French Foreign Office all the principal governments were invited to send dele-

[2] *Nature*, 74, 233.

gates. The attendance at this congress was large, and it showed the necessity of a close alliance between pure and applied science. Among the most important papers presented were those by Moissan on the electric furnace, which induced a highly important discussion on electrolytic problems and methods; Joly, on the applications of electro-chemistry; Grandeau, on the assimilability of the phosphates; Lippmann, on color photography; Kjeldahl, on the methods of determining nitrogen; Boroma, on the employment of aluminum in the construction of utensils; and Fernbach, on the utilization of the carbon dioxide arising from fermentation. Among the many interesting and important discussions may be mentioned those on the official graduation of instruments of precision, those on urine analysis, and those on food analysis. Nearly 2,000 members were present at the Paris meeting, and it required five large volumes to contain the report of the proceedings.

The third International Congress of Applied Chemistry was held in Vienna in 1898. The work was divided into twelve sections, and one of the chief questions before the congress was the adoption of uniform methods of analysis for commercial products and raw materials.

The fourth congress was held in Paris in 1900, and Moissan had charge of the selection of the committee of organization. This congress was held at the time of the Grand Exposition.

The fifth congress was held in Berlin in June, 1903. The imperial government had notified foreign governments officially of the meeting. Over 2,500 chemists attended and about 500 papers were presented for discussion. Several German societies held their meetings in conjunction with the congress, which was the most important and successful of all held up to that time.

The sixth International Congress of Applied Chemistry was opened at Rome in April, 1906. Its work was divided into eleven sections, and in each section an extensive program was arranged. Ramsay gave an address on the purification of sewage; Moissan lectured on the distillation of metals, and Frank on the direct utilization of atmospheric nitrogen. About 580 contributions were published in the "Atti" of the congress, occupying five large volumes.

The seventh congress was held in London from May 27 to June 2, 1909. The annual meeting of the Society of Chemical Industry was arranged at the same time, as well as several international organizations which dealt with special subdivisions of chemistry. As is well known on account of its recent occurrence, this congress was a worthy successor to the six preceding ones. It was divided into eleven sections with several subsections, making a total of seventeen in actuality, and was under the presidency of Roscoe and Ramsay. A characteristic feature of the London congress was the extension of the idea of the establishment of international commissions to recommend uniform standards of materials and methods for determining them.

The eighth congress is to be held in the United States under the presidency of Morley and Nichols. It is our good fortune to have Dr. W. H. Nichols, a charter member of the American Chemical Society and the active president of the congress, with us. This captain of American applied chemistry will tell us something of the aims and plans as far as determined for the next congress.

APPENDIX I

A short account of the Carlsruhe Congress of 1860 will no doubt be interesting.

Boussingault, who presided on the opening day (September 4), presented the following questions for discussion:

1. Would it be judicious to establish a difference between the term *atom* and *molecule?*

2. Would it be judicious to designate by the term *molecule* the smallest quantity of a body capable of entering into combination?

3. Would it be judicious to designate by the word *atom* the smallest quantity of a body existing in combination?

4. Should the term *compound atom* be suppressed and replaced by the words *residue* or *radical?*

5. Is the idea of equivalents empirical and independent of the idea of *atom* or *molecule?*

Kekule spoke upon the first three questions. He laid emphasis on the necessity for distinguishing between *atom* and *molecule;* furthermore, he insisted at some length upon the distinction which should be established, in his opinion, between the physical and chemical molecule, which are not always identical. He advanced the opinion that the size of the chemical molecule would always be of value in assisting purely chemical researches, and without the aid of any physical considerations.

Cannizzaro, in an impromptu address remarkable for profundity and style, combated the ideas of Kekule. He opined that the chemical and physical molecules were absolutely identical—that they could not be distinct one from the other. The gaseous molecule represented the chemical molecule, and it was impossible to conceive any other idea of a molecule. Secondly, the value of the chemical molecule could only be established in a certain manner, that is to say, by the vapor density, which alone could serve to establish the true formula of a compound.

Wurtz suggested that the congress should withhold any decision upon the distinction raised between the physical and chemical molecule. He thought that upon the first three questions they would all agree, so he passed on to the fourth proposition. Many chemists, among them Cannizzaro, Miller, Kekule and Persoz, spoke upon this subject, and their opinions were divergent. Therefore, after a very long discussion, the decision was adjourned, especially since the assembly appeared to be divided as to the resolution which they should come to. It should be mentioned here that the entrance of the illustrious Dumas, whose advent before the conclusion of the meeting was greeted with loud applause, did not apparently conduce towards an agreement on the question under discussion. On the fifth proposition of the commission being presented, it was put to vote and adopted.

On the fifth of September, with Dumas in the chair, the following propositions were presented for consideration:

1. Would it be desirable to place chemical notation in harmony with the progress of science?

2. Would it be judicious to adopt the principles of Berzelius, with the introduction of the necessary modifications?

3. Should any new signs be added to the number of symbols now in use?

Cannizzaro spoke first. The first question, he asserted, only required asking to be answered. An ardent defender of the unitary system, he did not see that it was necessary to preserve the notation of Berzelius, but would adopt that of Gerhardt. A compromise which would modify the binary system so as to introduce part of the unitary system seemed to him quite inadmissible; it would oblige chemists to resort to retrogression. It seemed preferable to him, therefore, to start from Gerhardt's theory, and to discuss his plan and modify it in parts if found necessary. The eloquent chemist of Genoa then discussed the fundamental ideas of the unitary system; in his remarkable plea in favor of the theories of Gerhardt, he was obliged to show the impossibility, in the actual state of science, to adopt any other notation than that of the unitary system. He concluded by requesting of all to admit at least in principle the new notation, and consequently employ the barred letters to represent the simple bodies corresponding to two volumes.

Strecker, Kekule, Will, Erdmann and Kopp spoke successively, some to corroborate the proofs given by Cannizzaro and to strengthen the doctrine which he defended, and others to combat it. All agreed, however, to adopt the use of the barred letters. Dumas considered that the time had not yet arrived to adopt a definite mode of notation; he expressed the desire that the modifications which were rendered necessary by the recent progress of chemistry be added to the system of Berzelius, while awaiting the final settlement of the question. One necessary point to which he directed the attention of the congress was the importance of looking at the requirements of instruction. In this respect, unity of language and theory seemed to be most desirable. Therefore, by an entire freedom in the drawing up of scientific memoirs the professors should endeavor to smooth as much as possible the difficulties produced by the divergence in these theoretical ideas.

To summarize the results of this congress, it may be said that every one present was agreed

as to the necessity of putting the language of chemistry in harmony with the actual state of the science; but the unanimous opinion of the assembly was that entire liberty in this respect was indispensable to the progress of the science. In defence of the views of Cannizzaro, however, it may be said that even though views have considerably changed and clarified since his time, and although one is compelled to regard the types of Gerhardt as insufficient from the modern point of view, yet the general character and comprehensive nature of Gerhardt's system leave little to be desired, and Gerhardt's services to chemistry have never been questioned.

APPENDIX II

LIST OF INTERNATIONAL SCIENTIFIC CONGRESSES EXCEPT CHEMISTRY[1]

Agriculture

International Congress for Agriculture and Forestry. Vienna, 1890.

International Agricultural Congress. The Hague, 1891. Seventh meeting: Wien, 1907.

International Horticultural Society. Chicago, 1893.

International Congress of Tropical Agriculture. Paris, 1905; Brussels, 1910.

International Institute of Agriculture. Rome.

International Congress for Dairy Husbandry. Fifth meeting: Stockholm, 1910.

International Congress of the Sugar and Distillery Interests. Second meeting: Paris, 1908.

Anatomy

International Congress of Anatomists. Geneva, 1905; Würzburg, 1907.

Anthropology

Universal Races Congress. London, 1911.

International Congress of the Ethnographic Sciences. Paris, 1889, 1900.

The Museums Association. Fourteenth Congress: Aberdeen, 1903.

International Reunion of Anthropologists. Cologne, 1907.

International Congress of Criminal Anthropology. Cologne, 1911.

Archeology

International Congress of Prehistoric Archeology and Zoology. Moscow, 1892.

Congress of Archeological Societies. The ninth convention took place in London in 1897.

International Congress of Anthropology and Prehistoric Archeology. The fourteenth meeting occurred in Dublin, in 1909.

International Congress of Archeology. Second meeting: Cairo, 1909.

Arts

International Literary Congress. 1878.

International Literary and Artistic Congress. Antwerp, 1885.

International Shorthand Congress. Third meeting: Munich, 1890.

International Congress of Arts and Science. St. Louis, 1904.

International Society of Sculptors, Painters and Gravers. 1909.

Astronomy

International Astronomical Association. Seventh Congress: Budapest, 1898.

International Geodetic Association. London, 1909; Brussels, 1910.

International Union for Cooperation in Solar Research. Oxford, 1905; Meudon, 1907; Mt. Wilson, 1910.

Conference Astrophotographique Internationale de Juillet. 1900.

Congrès International de Chronometrie. Paris, 1900.

International Congress of Navigation. St. Petersburg, 1908.

Botany

International Botanical Congress. Vienna, 1905; Berlin, 1906; Brussels, 1910.

[1] It is difficult to trace the careers of some of the international congresses of science; the above list is compiled more to indicate the extent to which international science has been fostered, rather than to serve as a record of the present day. However, wherever the present status of the various organizations is referred to in the journals of science, this is pointed out in the list. In order to discriminate between an international "conference" and "congress," the former term has been held to imply in its strict sense a committee or delegate meeting.

Various celebrations have really partaken of the nature of distinct congresses; for example, the International Celebration of the Jubilee of the Coal Tar Industry at London in 1906. Still other organizations have held or have initiated congresses which have been more or less of an international nature, although limited to only certain countries; for example, the Fifteenth Congress for Wine Culture at Heilbroun in 1896. National congresses are not given.

International Plant Fiber Congress. Surabaja, 1911.

Bromatology (vide Hygiene)

International Congress for the Repression of Adulteration and Frauds in Foods and Drugs. Four of these congresses have been proposed under auspices of the Society of the White Cross of Geneva.

International Congress of Analytical Chemists and Microscopists. Vienna, 1891.

International Congress of Alimentary Hygiene and the Rational Feeding of Man. Brussels, 1910.

International Congress on Pure Foods and Alimentary Substances. Second congress: Paris, 1909.

Chemistry

(See in body of text above.)

Education

International Congress on Technical Education. Brussels, 1880; Bordeaux, 1886 and 1895; London, 1897.

Congress on Education. Paris, 1889.

International Congress of Education. St. Louis, 1904.

International Congress on Moral Education. 1908.

Electricity and Physics

International Electro-Technical Congress. Frankfort, 1891.

International Conference on Terrestrial Magnetism and Atmospheric Electricity. Bristol, 1898.

International Physical Congress. Paris, 1900.

International Electrical Congress. Fifth congress: St. Louis, 1904.

Roentgen Congress. Berlin, 1904.

International Congress on Radiology and Ionization. Liege, 1905.

International Congress of Electrotherapy and Radiology. Amsterdam, 1908.

International Congress of Radiology and Electricity. Brussels, 1910.

International Electrical Conference. London, 1908.

International Office for Weight and Measures. Brussels, 1910.

International Photographic Congress. Fifth meeting: Brussels, 1910.

Engineering

Congrès International de Mécanique appliquée. Paris, 1890.

International Congress for the Unification of Methods of Testing. Meetings have been held in Munich, Dresden, Berlin, Vienna, Zürich and Stockholm (1897).

International Testing Conference. Brussels, 1906.

International Association for Testing Materials. Fifth congress: Copenhagen, 1909.

International Congress for Mining and Metallurgy. Fifth meeting: Düsseldorf, 1910.

International Aeronautical Conference. Paris, 1896; Strassburg, 1898.

International Congress on Aerial Locomotion. Verona, 1910.

International Congress of Naval Architects and Marine Engineers. London, 1897.

Congress of the International Institutes for the Iron and Steel Industries. Wien, 1907.

International Engineering Congress. Glasgow, 1901; St. Louis, 1904.

International Roads Congress. Paris, 1908; Brussels, 1910.

International Congress of Refrigeration. Second meeting: Vienna, 1910.

Fisheries

International Sea Fisheries Congress. Sables-d'Olonne, 1896; Dieppe, 1898.

International Fishery Congress. Washington, 1908 (fourth meeting).

Folk-Lore

International Folk-Lore Congress. Second congress: London, 1891.

Geography

International Geographical Congress. London, 1895; Berlin, 1899; Geneva, 1908; Rome, 1911.

International Maritime Congress. London, 1893.

International Conference for the Exploration of the Sea. Stockholm, 1899; Christiania, 1900.

International Council for the Study of the Sea. Sixth meeting: London, 1907.

Geology

International Geological Congress. Eleventh meeting: Stockholm, 1910.

International Congress of the Petroleum Industry. Third meeting: Bucharest, 1908; fourth meeting: London, 1909.

Hygiene (vide Bromatology and Medicine)

International Sanitary Conference. Paris, 1894.

International Congress of Hygiene and Demography. Fourteenth meeting: Berlin, 1907.

International Congress on School Hygiene. Nuremberg, 1904; London, 1907; Paris, 1910.

International Congress on Alimentary Hygiene. Brussels, 1910.
International Congress of Hygiene and Medicine. Buenos Ayres, 1910.

Mathematics

International Mathematical Congr ss. Zürich, 1897; Paris, 1900; Heidelberg, 1904; Rome, 1908; Cambridge, England, 1912. This congress is also referred to as the International Congress of Mathematicians.
International Statistical Congress. Twelfth congress: Paris, 1909.

Medicine

International Veterinary Congress. Ninth meeting: The Hague, 1908.
International Medical Congress. Budapest, 1909 (sixteenth meeting).
Congress of Internal Medicine. Vienna, 1908.
International Conference on the Sleeping Sickness. London, 1907 and 1908.
Pan-American Medical Congress. Fifth meeting: Guatemala, 1908.
International Conference on Tuberculosis. Fifth meeting: The Hague, 1907; Berlin, October, 1910; also Brussels, 1910.
International Congress on Tuberculosis. Washington, 1908; Rome, 1911.
Congress of Stomatology. Paris, 1907.
International Congress of Hydrology, Climatology and Medical Geology. Eighth meeting: Algiers, 1909.
International Physiotherapeutic Congress. Paris, 1910 (third meeting).
International Association of Medical Museums. Washington, 1907.
International Congress on Provision for the Insane. Vienna, 1908.
International Congress of Psychiatry and Neurology. Amsterdam, 1907.
International Dermatologic Congress. Sixth meeting: New York, 1907.
International Conference for the Study of Cancer. Second meeting: Paris, 1910.
International Surgical Society. Second congress: Brussels, 1908.
International Society of Tropical Medicine.
Non-Alcoholic Congress. Stockholm, 1907; London, 1908.
International Pharmaceutical Congress. Brussels, 1910.

Meteorology

Paris Meteorological Conference, 1896.
International Meteorological Conference. Innsbruck, 1905.

Orientalism

International Congress of Orientalists. Ninth meeting: London, 1892; Algiers, 1905.

Philosophy

International Positivist Congress. Naples, 1908.
International Congress for Philosophy. Third meeting: Heidelberg, 1908.
International Congress of "Free Thinkers." Prague, 1907.

Physiology

International Congress of Physiologists. Turin, 1901; Heidelberg, 1907; Vienna, 1910 (eighth meeting).
International Association of the Marey Institute. Brussels, 1910.

Political and Social Science

International Union for the Legal Protection of Workmen. Lugano, 1910.
Interparliamentary Union. Brussels, 1910.
International Congress of Americanists. Mexico, 1910.
Institution of International Law. Brussels, 1910.
International Congress of Comparative History. Paris, 1900.
International Congress of History. Rome, 1903.

Psychology

International Congress of Experimental Psychology. Paris, 1889; London, 1892; Munich, 1896. The Paris congress is also referred to as the Congress of Physiological Psychology.

Seismology

International Seismological Association. Strassburg, 1901; The Hague, 1907; Zermatt, 1909.

Zoology

International Zoological Congress. Paris, Moscow, Leyden; Cambridge, 1898; Berlin, 1901; Berne, 1904; Boston, 1907; Graz, 1910 (eighth meeting).
International Conference on Hybridization and Cross-Breeding. London, 1899.
International Ornithological Congress. Vienna, 1884; Budapest, 1891; Paris, 1900; London, 1905.
International Congress of Entomology. Brussels, 1910.

Unclassified

International Association of Academies. Third meeting: Vienna, 1907; fourth meeting: Rome, 1910.

L'Academie Internationale des Sciences, des Arts et Manufactures. Paris, 1860.

International Patent Congress. Vienna, 1873; Paris, 1878.

International American Scientific Congress. Buenos Ayres, 1910.

International Conference on Scientific Literature. Third meeting: London, 1900.

International Association of Leather-Trades Chemists. London, 1897.

Women's International Congress. London, 1899.

International Groups of Esperanto. Brussels, 1910.

International Prison Congress. Eighth congress: Washington, 1910.

CHARLES BASKERVILLE
COLLEGE OF THE CITY OF NEW YORK

WILLIAM JAMES

THE following minute on the life and services of Professor William James was placed upon the records of the faculty of Arts and Sciences, of Harvard University, at the meeting of October 18, 1910.

By the death of William James this university loses one who brought it high honor in many lands. As a man of science he left his mark on several departments of knowledge, while as a literary man he charmed all who read his lucid and picturesque pages. In him science and humanism were singularly combined. Learned as he was, he had none of the pedantry of the scholar. His books, besides illuminating their subjects, were creative of character, and through them he became one of the chief spiritual forces of our time.

He was born in New York, on January 11, 1842, of devout and independent parentage. Throughout life his studies were much disturbed by ill health, to which his dauntless spirit refused to bow. But a somewhat irregular education suited well a nature which was always fretted by routine and profited by whatever was unusual, diverse and expressive of individual character. In his youth he attended a Lycée in France and afterwards the University of Geneva, there gaining an unusual command of French. His German he acquired a few years later at the University of Berlin. In 1862–64 he was in the Lawrence Scientific School; then for four years in the Harvard Medical School, from which, two years later, he received the degree of M.D. He studied with Agassiz in the Cambridge Museum, and accompanied a scientific expedition to Brazil. He worked at painting under William Hunt, with John La Farge as a fellow pupil. His home training gave him power of expression, for in that home brilliant conversation and literary skill were traditional; while philosophy was at the same time set before him, on the one hand by his theological father, and on the other, by his rationalistic friend, Chauncey Wright. He early showed a strong distaste for such idealistic modes of thought as he believed obscured the concrete realities of experience.

The progress of his mind can be traced in the successive topics of his teaching. In 1873 he became an instructor in anatomy at Harvard; but soon, finding greater interest in physiology, he accepted an assistant professorship in that subject, in 1876. For the next three years, in addition to teaching physiology, he offered a course on the theory of evolution in the department of philosophy. In 1880 he abandoned physiology altogether, becoming in that year assistant professor, and in 1885 professor, of philosophy. He now gave himself enthusiastically to psychology, and under his energetic guidance a psychological laboratory was established here. But after the publication of his treatise on psychology, in 1890, his interest in it declined, and he turned more toward the history of philosophy and the theory of knowledge. In 1892 he resigned the directorship of the laboratory, and after 1897 was never willing to offer a psychologic course. Religion and metaphysics claimed him, and his last years were devoted to the elaboration of a comprehensive philosophy in which the portion known as pragmatism has occasioned wide discussion.

While unusually successful as a teacher,

Professor James's greatest enjoyment and influence came from his writings. For ten years before his death he taught either not at all or but a single course, and in 1907 he resigned his professorship in order to devote to writing whatever strength his ever weakening heart allowed. Throughout his academic career, with characteristic courage, he put out a series of papers filled with large learning, aggressive originality, popular sympathy and delightful language. Through continual practise he had made himself the master of a style which so fascinated the reader by its clearness and pungency that he was able by its aid to break down the distinction between technical and popular appeal, and render abstract subjects intelligible to the common man. Whatever he wrote, said, or did, was instinct with abounding life. Whether readers agreed with his books or dissented, all perceived that they vitalized their subjects. Several obliged a kind of new departure of human thought in their respective fields, the most notable being "The Principles of Psychology," 1890; "Talks to Teachers on Psychology," 1899; "The Varieties of Religious Experience," 1902, and "Pragmatism," 1907. Perhaps four short papers should also be mentioned: "The Feeling of Effort," 1880; "The Dilemma of Determinism," 1884; "Is Life Worth Living?" 1895; "The Will to Believe," 1896.

The honors received by Professor James were many and great. He was a member of national academies in America, France, Italy, Prussia and Denmark; was a doctor of letters at Padua and Durham, of laws at Harvard, Princeton and Edinburgh, of science at Geneva and Oxford. He delivered a course of Lowell Lectures in Boston, of Gifford Lectures in Edinburgh, of Hilbert Lectures in Oxford. He was one of the founders, and always a chief supporter, of the Society for Physical Research, a subject which profoundly interested him. More than once he was president of the American Psychological Association and of the Boston Natural History Society.

Yet all who knew William James thought less of his learning and renown than of his massive and inspiring personality. The universal admiration given him was ever mixed with love. From him men drew their ideals of human character and were grateful to him for being what he was. They found him the best of comrades—simple, engaging, generous in his estimates of others, tender as a woman, fair-minded, playful, reverent and unconventional, with a natural elevation of thought and manner which made all excellence easy in his presence. As we now recall that erect form, alert bearing, kind eye and masterful voice, we perceive how, in spite of his aversion to anything like intentional consistency, "his words and works and fashion too" were "all of a piece, and all were clear and straight."

SCIENTIFIC NOTES AND NEWS

The nineteenth annual meeting of the American Psychological Association will be held in Minneapolis during convocation week in conjunction with the Western Philosophical Association, the North Central Association of Teachers of Psychology, and the American Association for the Advancement of Science. The sessions are scheduled for Wednesday, Thursday and Friday, December 28, 29 and 30.

The tenth annual meeting of the American Philosophical Association will be held at Princeton, from December 27 to 29.

The American Physiological Society will hold its twenty-third annual meeting in New Haven, Conn., December 27–29. The place of meeting will be the Sheffield Scientific School, Yale University. The society will hold joint sessions with the American Society of Biological Chemists and the American Society for Pharmacology and Experimental Therapeutics. Professor W. H. Howell, of Baltimore, is the president and Professor A. J. Carlson, of Chicago, is the secretary of the society.

The Society of American Bacteriologists will meet in Ithaca, N. Y., December 28, 29, 30, 1910.

We learn from *Nature* that the Hungarian Academy of Science has this year awarded the Bólyai prize, of the value of 10,000 crowns, to

Professor David Hilbert, university professor of mathematics at Heidelberg. The jury consisted of two foreign mathematicians—Poincaré (to whom the prize was awarded in 1905) and G. Mittag-Leffler—and two Hungarians, Y. König and G. Rados, both from Budapest.

THE eightieth birthday of Professor J. D. Van Bemmelen, the eminent physical chemist of the University of Leyden, was celebrated on November 3. Some sixty memoirs have been received for a Festschrift to be published in his honor.

PROFESSOR GEORGE A. OSBORNE, the only remaining member of the original faculty of the Massachusetts Institute of Technology, has retired from the active duties of his chair.

IN honor of Dr. William Jack, who recently retired from the professorship of mathematics at Glasgow, there have been presented to the university a portrait of Dr. Jack, painted by Sir James Guthrie, and the sum of £300 for a William Jack prize fund, the prize to be awarded to the author of the best thesis on a mathematical subject for the degree of doctor of science.

WITH appropriate ceremonies, the twenty-fourth anniversary of the professorates of Dr. von Reuss, professor of ophthalmology, and Dr. Urbantschitsch, professor of otology, have been celebrated at Vienna.

THE College of Physicians and Surgeons of Philadelphia announces that the Alvarenga prize for 1910 has been awarded to Dr. M. Katzenstein, of Berlin, Germany, for his essay entitled "The Formation of an Arterial Collateral Circulation in the Kidney."

THE following appointments have been made to the staff of the Rockefeller Institute for Medical Research: Francis Henry McCrudden, M.D., chemist to the hospital; Thomas S. Githens, M.D., fellow in the department of physiology and pharmacology; James B. Murphy, M.D., fellow in the department of pathology and bacteriology; A. R. Dochez, M.D., bacteriologist to the hospital; F. Medigreceanu, M.D., laboratory assistant to the hospital, and W. H. Manwaring, M.D., assistant in pathology.

DR. ERNST LEDERLE, commissioner of health of New York City, has formed an advisory board of statisticians to the health department. With Commissioner Lederle the board will consist of Dr. Roger S. Tracy, formerly registrar of the department, Dr. William S. Guilfoy, the present registrar, Dr. Cressy L. Wilbur, Professor C.-E. A. Winslow, of the City College, and Professor Walter F. Willcox, of Cornell University, who is also consulting statistician of the state department of health. The board will endeavor to outline a plan for the better computation of health and mortality statistics.

DR. A. J. MCLAUGHLIN, assistant director of health in the Philippines, and Dr. P. K. Gilman, assistant professor of surgery in the Philippine Medical School, have left for the United States on leave of absence.

DEAN EUGENE DAVENPORT, of the College of Agriculture of the University of Illinois, with the members of the committee on agriculture, the board of trustees and the sub-committee on agriculture of the State Farmers' Institute, have started on a tour of inspection of agricultural colleges in Nebraska, Iowa, Minnesota and Wisconsin. On their return they will make a report upon which will depend the share which the College of Agriculture will receive in the biennial budget of the university which is to be submitted to the next session of the state legislature.

PROFESSOR C. T. KNIPP, of the physics department of the University of Illinois, is in Europe on a year's leave of absence. He will spend the greater part of the year in Cambridge studying under Professor J. J. Thomson.

SHINKICKI K. SUZUKI, the Japanese chemist who was detailed by the U. S. government at the College of Agriculture of the University of Wisconsin, has been relieved of his work and has been sent to Europe on a special mission by the U. S. Department of Agriculture.

DR. HIPPOLYTE GRUENER, professor of chemistry in the College for Women of Western Reserve University, is absent on leave for the year, which he is spending in Europe. Mr.

Carl Byron James, assistant professor of biology in Adelbert College and the College for Women, is also absent upon leave for the year.

Dr. Eugen Oberhummer, professor of historical and political geography in the University of Vienna, will deliver three lectures at the Johns Hopkins University on November 14, 15 and 16. His subjects are: "Developments and Methods of the Geography of Man," "Races and Peoples of Europe," "Principal Geographical Features of Austria and Hungary."

On October 29 Professor S. F. Acree, of the Johns Hopkins University, delivered a lecture before the Chemists' Club of Washington, D. C., on the progress of the researches conducted in his laboratory. The subjects discussed were tautomerism, dilatometry, catalysis, reactions of alkyl halides and the theory of oxidation and reduction. The discussion was followed by a smoker.

Dr. A. C. Abbott, professor of hygiene and bacteriology, in the University of Pennsylvania, gave two lectures at the University of Maryland, on November 9 and 10. The subjects were: "The Function of the Municipality in Public Preventive Medicine" and "The Interdependence between the Laboratory and the Clinical Investigators."

Mr. Henry S. Bryant, president of the Geographical Society of Philadelphia, gave the annual address on November 2, his subject being "The Land of the Golden Dragon, or Travels in French Indo-China."

William Henry Brewer, professor emeritus of agriculture in the Sheffield Scientific School of Yale University, for many years a prominent figure in American science, died on November 2, at the age of eighty-two years.

Arthur Erwin Brown, secretary of the Zoological Society of Philadelphia and active head of the Zoological Garden, the author of contributions to herpetology and mammalogy, died on November 1, at the age of sixty years.

Monuments to Professor Guzzenbaur and Professor Nothnagel, two eminent professors of medicine at the University of Vienna, have been unveiled.

M. Henri Dunant, of Geneva, founder of the Red Cross Society, died on October 30, at Hilden, Switzerland, aged 82 years.

Professor Faraboeuf, professor of anatomy at Paris, has died at the age of sixty-nine years.

UNIVERSITY AND EDUCATIONAL NEWS

The General Education Board has made conditional appropriations amounting to $725,000, distributed as follows: Baylor University, Waco, Tex., $200,000; Trinity College, Durham, N. C., $150,000; University of Chattanooga, Tenn., $150,000; Meredith College, Raleigh, N. C., $50,000; Wesleyan Female College, Macon, Ga., $100,000, and Amherst College, Amherst, Mass., $75,000.

Wooster University has received $100,000 from Mrs. J. S. Kennedy, of New York, for the erection of a dormitory for men.

The Academy of the University of Illinois, which was established in 1876, is to be abandoned. In discontinuing the academy the board of trustees have in mind a plan to establish a model high school at the university in connection with the school of education.

The foundation-stone of new engineering laboratories for Liverpool University was laid October 22 by Mr. T. Fenwick Harrison. The cost of erection of the building will be met by a fund of £35,000, which has been provided by Mr. Fenwick Harrison, Mr. J. W. Hughes and Mr. Heath Harrison.

In the "School of Higher Studies" of the National University of Mexico, recently founded, professors are being engaged to give courses lasting each three months. Such an appointee has the title professor and is to reside at Mexico City each year for three months during his term of office. Among those already appointed on these terms are Professor Richet (Paris, physiology), Capitan (Paris, ethnology), Boas (New York, anthropology), Rowe (Philadelphia, political science), Reiche (Germany, botany), Baldwin (Baltimore, philosophy and social science). Professor Baldwin opened the series with a course entitled "The Individual and Society"

which is to continue until January, 1911, and to be followed by a "seminary" course in 1911–12. Professor Boas begins in November, 1910, Professor Richet in January, 1911, etc. The qualifications for enrolment are graduation from a university school (college) and high honors in subjects related to that to be pursued. The first course given under these restrictions had an enrolment of fifty-five. It is expected that these professors will devote their courses to research as well as to instruction.

AT the University of Pennsylvania, Dr. Arthur Holmes and Dr. F. M. Urban have been advanced to assistant professorships and Mr. S. F. Fernberger to an instructorship in psychology.

AT Western Reserve University, Mr. William L. Dolley has been appointed instructor in biology, and Mr. Edward H. Sensel instructor in chemistry.

MR. A. E. SHIPLEY, F.R.S., fellow and tutor of Christ's College, Cambridge University, has been elected master of the college in succession to the late Dr. John Peile.

THE dedication exercises for the new building for entomology, zoology and geology at the Massachusetts Agricultural College will be held Friday, November 11. Dr. L. O. Howard, of Washington, will give the dedicatory address. The building is 100 by 120 feet, of colonial style and of the letter H design. It is made of brick, steel and concrete, thus giving a fire-resisting structure. It was built and equipped at a cost of about $95,000. In the basement are spacious laboratories for geology and mineralogy and a rock museum; also a laboratory for insecticide analysis and two rooms for spraying apparatus. On the first floor are two large laboratories for zoology and the main floor of the zoological museum; also two rooms and an office for the experimental work in entomology with a greenhouse attached and three offices for the department of zoology and geology. On the third floor are two large laboratories for entomology, an insect collection room, a small lecture room and the library; also a laboratory for advanced zoology, the gallery of the zoological museum and two offices for the department of entomology. In the main part of the building there is also a large amphitheater lecture hall. Professor H. T. Fernald is at the head of the department of entomology and Professor C. E. Gordon at the head of the department of zoology and geology.

DISCUSSION AND CORRESPONDENCE

THE LOCUS OF A MOVING POINT WHEN THE QUOTIENT OF ITS DISTANCES FROM TWO FIXED POINTS IS CONSTANT

REFERRING to the digest of a paper by Mr. John F. Lanneau under the above-mentioned title, in SCIENCE, No. 806, it may be of interest to state that the locus is of importance in the theory of electric cables and transmission lines. The circles represent the directions of magnetic lines of force, created by a current through a loop consisting of two parallel wires. The orthogonal system of circles corresponds to electrostatic stresses between the wires. Or else, the first system determines equipotential electrostatic surfaces, while the second system gives surfaces of equal electromagnetic potential.

When telephone wires run parallel to a power transmission line it is of importance to place each telephone loop in such a position with respect to the power line, as to have a minimum of inductive disturbance, that is to say, a minimum of roaring in the telephone. For this purpose it is convenient to draw the circles in question, representing magnetic lines of force around the power transmission line. The two wires of the telephone line must lie on the same circle. In the case of a three-phase line the same is split, for the purposes of computation, into two single-phase lines, and circles are drawn for each loop separately. The telephone wires are located so as to lie approximately on some one circle belonging to each single-phase loop.

The two fixed points in Mr. Lanneau's problem are *inverse* points with respect to the system of circles; this is according to a well-known theorem in elementary geometry. They do not coincide with the centers of the wires in the electrical problem. The cross-sections

of the wires belong to the system of the loci, and the fixed points are found from the condition that the radius of the circle is a mean proportional between the distances from the center to the inverse points.

Cornell University, V. Karapetoff
June 25, 1910

QUOTATIONS

THE DOCTOR AND THE PUBLIC

In an article entitled "The Widening Sphere of Medicine," but which might as appropriately have been entitled "The Doctor and the Public," read last year as the Shattuck lecture before the Massachusetts Medical Society, and now printed by the department of neurology of Harvard University,[1] Dr. E. W. Taylor, of Boston, indicates and attempts to estimate the significance of various well-defined tendencies in present-day medicine. Dr. Taylor was led to this subject by a consideration of the rapidly widening scope of medical theory and practise, with its new and unique opportunities, and the apparent disinclination on the part of many men of promise and varied attainments to take up medicine as a career. What, however, must strike every reader of Dr. Taylor's wise and scholarly address is not so much the natural extension and development of the scope and attainments of medical science, extraordinary though these have been, nor the avoidance of medicine as a career by men of outstanding ability—an economic problem possibly more felt in America than here—but the manner in which the writer discerns the new conceptions and ideals which have accompanied the development of medical science, lays bare the significance of certain economic adjustments, and, as if from some point of vantage, scans the signs of the times and foretells the dawn of a new era in the aims and practise of medicine.

Archbishop Trench said that a man might fairly be assumed to remember clearly and well for sixty years back, and that only five of these sixties would carry us back to the age of Spenser, and not more than eight to the time of Chaucer and Wiclif. In that time the English language has become metamorphosed; yet any one of the imagined series of eight men, Dr. Trench said, would have denied that there had been in his lifetime any change worth mentioning. It can not be said that the statement holds good for medicine. The changes in a single lifetime have been so great, the innovations—anesthesia, antisepsis, bacteriology, and in the minute anatomy of the body, to name only a few—so startling, that new sciences have sprung into being and the medical man of to-day speaks a different language even from his immediate predecessor. These changes strike everybody, but changes—perhaps more revolutionary, though less noticeable—are now in process, and they concern the relations susbsisting between the medical man and the public. It is to this altered phase that Dr. Taylor draws attention, and it is to meet the altered conditions that he desiderates corresponding adaptations in the teaching faculties.

One of the first of these changes to which Dr. Taylor alludes is the absence of secrecy. From time immemorial medicine has been a secret art. Even a generation ago the apprentice was bound by agreement "not to reveal or to divulge any of his master's secrets *or the secrets of his profession*"; to-day the medical practitioner, in his relations with a private patient, frequently explains not only the nature of the case, but the *rationale* of the treatment, with the hope of securing the patient's willing cooperation. What Dr. Taylor calls this gradual removal of mystery has had far-reaching effects. The doctor's mere dictum no longer carries weight; "his Latin prescriptions, if he still writes them, are doubtfully scrutinized, and the patient more and more demands to know what he is taking and why; he readily seeks other advice outside the profession if the expected benefit does not result from the treatment prescribed. . . . The doctor of the present day shares the practise of medicine as never before with persons

[1] "The Widening Sphere of Medicine," the Shattuck lecture before the Massachusetts Medical Society, June, 1909, by E. W. Taylor, M.D., Boston, department of neurology, Harvard Medical School, Vol. IV., 1910.

wholly without or with inadequate medical training." As a consequence of this changed relation, Dr. Taylor says that the profession stands at a parting of the ways, and he asks, "Will it proceed, fenced in by conventionality and the traditions of the past, or will it respond to the insistent demands of the times and widen its sphere of activity?"

As a natural extension of this "letting in of the light," the public has become increasingly interested in medical affairs. Public lectures are given, and magazine articles for popular reading are printed, on the greatest variety of medical topics. Concerning these Dr. Taylor says that it is a striking sign of a changed attitude that not many years ago any popular exposition of medicine by a physician was looked upon as a doubtful procedure, indicative of personal self-interest. This narrow state of mind, he says, is happily past, and he looks for the development of a useful, if small, number of physicians who have the capacity and inclination to widen the scope of medicine by these means.

The entering wedge of this movement, however, Dr. Taylor considers to have been the campaign against tuberculosis. He quotes Professor Osler as having said that tuberculosis was no longer a medical, but a social, problem. A recent tuberculosis exhibition in New York had an attendance of 750,000 people, and these figures have been approached in many smaller cities throughout the United States. In this campaign against tuberculosis the profession has enlisted not only the sympathy and practical support of the public, but its active cooperation.

In America, Dr. Taylor cites also the development of "social service" as one of the most significant features of the widening of medical activity. Beginning some years ago in the Massachusetts General Hospital, and since adopted at a number of institutions in Boston, departments have been formed for the purpose of studying the underlying causes of disease and the social problems connected therewith, through the agency of trained workers under medical direction. The abandoning of secrecy, the shifting of medicine from an empiric basis to one founded on scientific conclusions drawn from data accessible to every one, and the enlistment of the public in many medical activities is making the profession less and less a closed body of experts who, to quote a letter which appeared in the *Journal* of August 20, "practise medicine as between man and man, accepting individual responsibility and accepting individual reward," and more and more an organized department of public and social service, with ramifications extending in every direction.

This change is naturally not without its attendant disadvantages. The response to the public demand for information has not always been wise either in matter or form; the writers of popular treatises have too often provided empty dogma in place of proved fact; the susceptibility of the public mind to the potent influences of suggestion has at times been overlooked, and in one important department, that of psychotherapy, the public has been left largely to its own devices, to become the victims of Christian Scientists and other dabblers in the occult, or, occasionally, the sacrificial offerings of well-intentioned but misguided clergymen.

A field grows at its fringes, and it is here that the weeds abound. As a recent correspondence in our columns will show, the sphere of "spiritual" or "mental" healing is at times, and quite erroneously, supposed to be a kind of "no man's land." Such a designation can not be too strongly rebutted. What usually passes under the name of "spiritual healing" is at bottom—unless it be miraculous—nothing other than treatment by suggestion, a department appertaining solely to medicine, and one to be undertaken by no one unless specially conversant with psycho-analytic and psycho-therapeutic methods. Surely the clergyman who undertakes the spiritual healing of diseases—such as, for example, myasthenia gravis—does not realize the loss he and his patients suffer by his exchanging his honorable calling for another in which he has no proper training. Doubtless, as Dr. William Salmon says in his "Ars Chirurgica" (London, 1698), there have always been those who,

> Whatever their Qualifications were before, whether a Preacher, a Reader of Prayers . . . or a Bellows-blower, or Nothing at all, it matters not much, for at once, in the twinkling of an Eye, as it were, after a Miraculous manner, they can mount from the profundity of Ignorance to the Pinnacles of Knowledge; from the Abyss of Nothing, to the Altitude of being Doctors of Physic, intruding into our Business with all the Impudence imaginable, to the great Abuse and Scandal of the Medical Art.

But the point which Dr. Taylor wishes to press home is that the enormous spread of these irregular practises at the confines of the medical art is permitted by the failure of teaching bodies to adjust their curriculums in harmony with the fullest requirements of the community.

> The profession at large is rising to a clear recognition of its widening responsibilities in the broadest social and even political relationships. The medical schools are still bound by the traditions of medical education as it was thirty years ago.

So far as psychiatry and this country are concerned, we hope that the successive resolutions of the Medico-Psychological Association and the British Medical Association will not be in vain, and that ere long thorough tuition in all branches of psychological medicine will be offered by every medical school. For the broader issues of Dr. Taylor's discourse we would refer readers to the article itself, but it is pertinent to the occasion to say here that he prophesies the development of an elective system of medical education.

> It is not to be doubted that the wasteful method of demanding a detailed course in surgery, for example, from the prospective internist, or of obstetrics from the future bacteriologist, will give place to a more rational conception of the use of time. An elective system modified to meet the special demands of the situation is an inevitable outcome of the present state of affairs if our medical schools are to be the centers of educational activity which their equipment justifies.

In the foregoing we have of set purpose attempted merely to adumbrate the changing relations between the profession and the public as indicated by isolated instances selected from an address which should be read in its entirety. Although descriptive of American conditions and intended for American ears, Dr. Taylor's address is in some degree applicable to this country. The same changes are observable, and there is the same need for constant readjustment of medical teaching to meet these changes. Nebulous as yet, the altering conceptions of the functions and practical duties of the medical man may take this or that shape, may be guided by a united profession into fertilizing rains or crystallized by one-sided legislation into the first snows of the winter of our discontent. Readers of the deeply interesting correspondence in our columns upon proposed legislative changes will have observed the sharp cleavage of opinion even amongst medical men upon these proposals. It is outside the purpose of this article to discuss these matters, but it is evident that if the profession is to secure in the future the just reward of its labors and to maintain its rights in the approaching conflict between individualism and collectivism, it must frankly recognize the altering status of the medical man in the social economy, decide upon a common plan of action to meet changing conditions, and present a solid front to all attempts to encroach upon its legitimate territory.—*The British Medical Journal.*

SCIENTIFIC BOOKS

A History of the Logarithmic Slide Rule and Allied Instruments. By Florian Cajori, Ph.D.

The slide rule enjoys a wide popularity, being employed in practically all of the large engineering schools in addition to its use by practising engineers. Parenthetically it may be safely asserted that mathematicians in general do not avail themselves of the services of this instrument. Because of the wide use, such a history as this by Professor Cajori of the gradual development of the slide rule through the course of three centuries should appeal to a large circle of readers. While written in popular style for this larger class of readers and not primarily for the historian of science, yet the work bears evidence of considerable research in the literature of the

subject. In consequence it appeals also to those interested in the history of mathematics.

A brief résumé of the conclusions reached is in place, especially because of the fact that the most important result of Professor Cajori's investigation appears in the addenda, having no mention either in the preface (which in every well ordered book should be written after all the addenda are completed), nor in the index.

In 1620, only six years after the publication of Napier's "Mirifici logarithmorum canonis descriptio," Edmund Gunter, who was professor of astronomy in Gresham College, London, designed a logarithmic scale of numbers, in which the numbers 1, 2, 3, . . . 10 (not "digits," however, as Cajori has it), are placed upon it in such a way that the ratio of the distance from the point 1 to the point 2 to the distance from point 1 to any other point equals the ratio of the logarithm of 2 to the logarithm of the number of the other point, *i. e.*, distances are taken proportional to the logarithms of the corresponding numbers. Compasses were used to take off distances, thus serving the purpose of the slide. The writer who did most in spreading information about Gunter's "logarithmic line of numbers" was an English lawyer Edmund Wingate, 1593–1656, to whom the invention of the slide rule has frequently been erroneously attributed, as occurs indeed in the text of the work under discussion.

Some time before 1630 William Oughtred, a preacher known as the inventor of the symbol $\times$ for multiplication and the proportion symbol ::, devised two rules to be applied to each other, obviating the necessity of the compasses. Oughtred further placed such logarithmic lines upon concentric circles, one circle being movable. In place of the slider a pair of pointing radii were used. Oughtred explained his invention in 1630 to his pupil William Forster, who in 1632 made it public in a book entitled "The Circles of Proportion and the Horizantall Instrument." In 1633 Forster published an addition with an appendix, "The Declaration of the Two Rulers for Calculation." The sliding feature seems to have been effected in 1657 by the surveyor Seth Partridge, although not explained in print until 1672. The first runner was constructed by John Robertson (1712–76), a teacher of mathematics. Robertson's work was published two years after his death by one William Mountaine.

Of recent improvements noteworthy is the fact brought here to the attention of American readers that the Mannheim type of slide rule, now in use in America, is being supplanted in France by the règle des écoles, a slide rule with somewhat simpler arrangement of the scales affording greater accuracy.

Forster's account of his conversation with Oughtred is worth repeating. He says:

> I wondered that he could so many yeares conceale such useful inventions, not onely from the world, but from my selfe, to whom in others parts and mysteries of Art he had bin so liberall. He answered, That the true way of Art is not by Instruments, but by Demonstration: and that it is a preposterous course of vulgar Teachers, to begin with Instruments and not with the Sciences, and so instead of Artists to make their Schollers only doers of tricks, and as it were Juglers: to the despite of Art, losse of precious time, and betraying of willing and industrious wits unto ignorance, and idlenesse.

Newton's employment of logarithmic scales for the solution of cubic and biquadric equations is of interest. Professor Cajori ascribes to Newton the first suggestion of a "runner" because Newton's explanation requires that straight lines be drawn across two scales. Oughtred's sliding radii would seem to have a better claim.

The statement is made (p. 45) that the author has failed to find any references to Sauveur, Camus and Clairaut in French works of the eighteenth century. Bion's "Traité de la Construction et des principaux Usages des Instruments" refers to Sauveur as the inventor of a logarithmic gauge, explaining the instrument and giving a cut of it. Further the author remarks (p. 46) that, "so far as we have observed, the early English designers of slide rules (Wingate, Oughtred, Partridge, Coggeshall, Everard) are never mentioned by continental writers of the eighteenth century." But Montucla ("Histoire de Mathématique," Paris, 1799) mentions

Gunther, Wingate, Oughtred, Forster and Partridge. Heilbronner ("Historia Matheseos Universæ," Leipzig, 1742) includes Wingate and Gunter, while La Lande ("Astronomie," Paris, 1792) refers to Gunter as known for his scale of logarithms. These from the limited works at my hand that would be likely to mention these men.

Gunter's "Description and Use of the Sector, Cross-staff, and other Instruments," London, 1624 (p. 2), should be, according to the British Museum Catalogue, "The description use of the sector, crosse-staffe, and other instruments." The printed title page of a copy in the British Museum is dated 1623. "Horizantal" in the title of Forster's work (p. 11) should be "Horizontall," and the title of Wingate's publication (p. 9) should begin with "The." I note three "λ"s in the Greek word in footnote on page 21. There are omissions in the index, *e. g.*, Mehmke and other names of the preface. Perry and Segner (preface, page iii) are hardly entitled to be called "advanced mathematicians." The given bibliography of the slide rule receives undue prominence as it is by no means complete, a fact shown by the most casual reference to the articles on the slide rule in the "International Catalogue of Scientific Literature, Mathematics," and to the Royal Society of London's "Catalogue of Scientific Papers, Subject Index, Pure Mathematics."

Especially worthy of commendation are the abundant photographic reproductions of diagrams from the originals. The most serious criticism to be brought against this publication is that it was placed upon the market with such important corrections in the addenda. Doubtless it would have been expensive to correct the fundamental errors in the text shown by the results stated in the addenda, yet the value of the work is considerably lessened by this omission. The publishers state in a footnote that copy of the addenda was received after the text was printed. It is to be hoped that some time an edition may appear in which these important conclusions are embodied in the text.

L. C. Karpinski

Birds of South Carolina. By Arthur Trezevant Wayne, Honorary Curator of Birds in the Charleston Museum. With an introduction by Paul M. Rea, Director. Contributions from the Charleston Museum, I. 8vo, pp. xxi + 254. Charleston, S. C. 1910.

The present work is based primarily on the personal observations of the author continued for nearly thirty years, mainly in the coast region of the state, to which it was his intention originally to limit its scope. The introduction by Professor Rea, based largely on manuscripts furnished by the author, whose prolonged illness rendered this assistance necessary, treats of the physical divisions of South Carolina, and the history of South Carolina ornithology, which begins with Catesby's "The Natural History of Carolina, Florida, and the Bahama Islands," published in two folio volumes in 1731–48. The later contributions, by various authors, are duly noted. The main body of the work consists of a systematic list of the "Birds of the Coast Region" (pp. 1–204; 309 species), followed by an annotated list of additional species from the interior of the state (pp. 205–213; 28 species), and a "Hypothetical List" (pp. 215–222; 22 species). A bibliography of about 200 titles and a good index complete the volume.

As a faunistic contribution, it is a work of high value, the species of the coast region being not only very fully annotated, but the annotations present a summary of the long field experience of a conscientious and exceptionally careful and competent observer, enthusiastically interested in his work. The records made by other authors are not neglected and loose or erroneous statements receive critical attention. Mr. Wayne has largely, for many years at least, had this especially interesting field almost to himself, and since about 1886 has added over thirty species to the known fauna of the region and contributed a long list of minor papers on its birds. In bringing together in a handy volume the results of his ornithological observations, he has rendered a grateful service to his

fellow-workers and produced a work which will always remain the standard source of information on the subject of which it treats—the birds of the coast region of South Carolina, their relative abundance and manner of occurrence at the date of its publication.

J. A. A.

BOTANICAL NOTES

BOOKS ON MOSSES

TEN years ago Dr. A. J. Grout brought out a little book with the title "Mosses with a Hand Lens," which was intended to "give by drawings and descriptions the information necessary to enable any one interested to become acquainted with the more common mosses with the least possible outlay of time, patience and money."

Five years later, encouraged by the reception accorded his venture the author brought out a second, greatly enlarged edition, in which he included the liverworts also. That these little books have been most useful needs no proof here. They have made it possible for many a student to study mosses in field and forest as he studied ferns and flowering plants. Some one should give us similar books on the fungi (and lichens) and the freshwater algæ, and for seaside dwellers the seaweeds might well receive a similar treatment.

In the optimistic mood which the success of his little moss book induced, Dr. Grout projected a larger work which he began publishing in German fashion in successive "parts," under the title "Mosses with Hand Lens and Microscope." The first of these parts appeared in 1903; the second in 1904, the third in 1906, the fourth in 1908, and the fifth (concluding) in 1910. We have now the complete work, making a large octavo volume of 416 pages, including 89 full-page plates, and 220 text figures. Many of these are from *Bryologia Europaea,* and Sullivant's *Icones Muscorum.* There is no attempt to include all the mosses of the region (northeastern United States) but the author has made a judicious selection, for which his long experience as a teacher as well as a bryologist has well fitted him. The keys to the genera and species, together with the carefully drawn descriptions, make it rather easy for the pupil to find the name of any ordinary moss.

The book closes with a key to sterile specimens, and a good index. A good glossary (illustrated) is given in the introductory part of the work (pp. 37–44).

The author is to be congratulated upon the completion of this notable book, and students of the mosses will be glad to know that he offers it now as a bound book. (New Brighton, N. Y.)

THE GRAY CENTENARY

THE Botanical Seminar of the University of Nebraska will celebrate the one hundredth anniversary of the birth of Dr. Asa Gray on Friday, November 18, 1910. At a general convocation to be held at eight o'clock in the evening of the above day in the botanical lecture room in Nebraska Hall, the following papers will be read:

"Gray's Writings to be found in the Botanical Library," Professor E. R. Walker.

"Gray's Manuals and Floras," Professor G. H. Coons.

"Gray's Text-books," Professor R. J. Pool.

"Gray's Influence as a Teacher," Professor E. M. Wilcox.

"Reminiscences and Letters," Professor C. E. Bessey.

The above papers will be assembled by the "Lord Warden" and printed as a publication of the seminar.

THE NUMBER OF KNOWN SPECIES OF PLANTS

IN some work upon which I have been engaged recently it became necessary to bring together in compact form what is known as to the number of kinds (species) of plants with which botanists have enough acquaintance to permit of their systematic arrangement and enumeration. The result is that roughly speaking we may say that there are now known about 210,000 species, distributed as follows:

Myxophyceae (Blue Greens)	2,020
Protophyceae (Simple Algae)	1,100
Zygophyceae (Conjugate Algae)	7,000
Siphonophyceae (Tube Algae)	1,100
Phaeophyceae (Brown Algae)	1,030

Carpophyceae (Higher Algae)	3,210
Carpomyceteae (Higher Fungi)	63,700
Bryophyta (Mossworts)	16,600
Pteridophyta (Ferns)	2,500
Calamophyta (Calamites)	20
Lepidophyta (Lycopods)	900
Cycadophyta (Cycads)	140
Strobilophyta (Conifers)	450
Anthophyta (Flowering Plants)	110,000

About eighteen years ago Saccardo made some rather careful estimates of the numbers of species of plants, and a translation of his paper made by Dr. Roscoe Pound was published in the *American Naturalist* for February, 1894. In that paper Saccardo makes a number of very interesting and ingenious calculations and estimates and reaches the conclusion that at that time there were known nearly 174,000 species of plants, distributed as follows:

Algae	12,178
Fungi (including Lichens)	45,203
Liverworts and Mosses	7,650
Equis, Marsil, Lucopod	565
Ferns	2,819
Phanerogams	105,231
	173,706

Upon these figures he then estimates that "the flora of the world when it is completely enough known will consist of at least 385,000 species, that is 250,000 fungi, and 135,000 species of the other groups." Adding 15,000 as the probable number of new species that it may reasonably be presumed will be found outside of the fungi, and we have 400,000 as the grand total of plant species in the world. These he estimates may require 150 years of work by botanists, in other words "our remote grandchildren" may be confronted by this vast array of species.

In his paper Saccardo contrasts these later numbers with earlier ones, as follows: Theophrastus, about 2,200 years ago, knew about 500 species of plants; Dioscorides 1,900 years ago knew 600 species; Bauhin 260 years ago knew 5,266; Linné 150 years ago knew about 8,551; DeCandolle (in 1819) reckoned about 30,000 phanerogams alone, and this was increased by Lindley (in 1845) to nearly 80,000 and by Duchartre (in 1885) to 100,000; the latter at the same time estimated the cryptogams at 25,000.

HOW TO TEACH BOTANY

That there is need of improvement in our teaching of botany scarcely needs arguing, especially when we consider the teaching in the high schools of the country at large. In fact when we think of the thousands of young people who yearly enter the classes in general botany in the colleges and universities, and then consider the annual hunt by heads of botanical departments for men (or women) who are prepared to fill even minor places as teachers or investigators, we are sometimes tempted to question whether any of us know how to teach our science aright. Upon the latter point the writer would like to take part in a serious Seminar Conference in Minneapolis during the meeting of the American Association for the Advancement of Science, and he here suggests to the officers of Section G that they make provision for such a seminar on one of the evenings at some convenient place. So, leaving the question of the apparent inefficiency of college and university teaching, every teacher who has had to evaluate and build upon the botany of the high schools realizes very fully that there is very much poor teaching of the subject which makes it in every way fruitless. Too often after a half year or a year spent in the study the pupil has acquired neither culture nor training therefrom; instead, he has a mass of unrelated and rather dimly outlined botanical facts whose incoherency and vagueness preclude any mental training, and whose lack of relation to the daily life of the community makes impossible the suggestion that they may contribute to the general education, that is the culture, of the pupil.

Now it is to remedy this state of things in botanical pedagogy that Professor Ganong, well known as a most successful teacher, has brought out a new and enlarged edition of his "Teaching Botanist" (Macmillan) a book of somewhat more than four hundred pages. In these he discusses "The Place of the Sciences in Education, and of Botany among the

Sciences," "What Botany is of Most Educational Worth?" "The Training and Traits of the Good Botanical Teacher," "The Methods and Marks of Good Botanical Teaching," "Drawing and Description," "Botanical Laboratories and their Equipment," "Botanical Collections and other Illustrations," "Botanical Books and their Use," etc., and then takes up *seriatim* particular directions for teaching those parts of the science that he considers it possible to teach in the high schools. The book closes with reprints of two committee reports, viz.: Report of the Committee of Education of the Botanical Society of America, and the Report of the Committee of the Association of Colleges and Secondary Schools of the North Central States.

It is impossible to point out here all the good things this book contains. Each chapter might be quoted here entire with profit for the teacher-reader, but perhaps one of the most helpful is that on botanical books, with its many titles and very discriminating notes. The teacher who will carefully read this chapter will be in no danger of wasting money on poor books, or those not applicable to the particular conditions of his school.

In the second part of the book the prevailing idea that the seed is a good starting point is adopted. The writer of this notice does not have that veneration for seeds which so many of his colleagues have, and does not feel it incumbent upon him to regard seeds as having prior or paramount rights in the botanical laboratory or lecture room. Of course the well worn pedagogical axiom that in our teaching "we must proceed from the known to the unknown," is brought out to show that this old-time sequence is the truly orthodox one. But in fact how much that is of any scientific value whatever does the high school pupil know about a seed, one of the most complex of all plant structures? It would be difficult indeed to light upon anything anywhere in the whole plant kingdom that the pupil knows less about. And yet we ask the pupil to start with this complex thing, and make out a good deal of its structure, giving names to this and that part, of whose real nature and significance he can have no conception until he has studied some of the plants from which seed-bearing plants have been evolved. So, the writer has no use for the sequence here recommended, but he cheerfully testifies to the excellence of the presentation of the structure of seeds, their morphology, ecology, germination, etc., from the standpoint taken in this book. Professor Ganong's laboratory directions are admirable, and no doubt the pupils that are brought up this way will learn accurately a great many things that many teachers think should enter into high school botany. After thus ranging the structure of the higher plants, in accordance with the axiom quoted above, there is a brief chapter of twenty-five pages given to the Natural History and Classification of the Groups of Plants. This is where the writer would start his high school pupils, beginning with simple, one-celled plants and taking in succession higher and more complex forms until the flowering plants were reached, quite as Professor Ganong suggests in this part of his book. Then, and not until then, could the pupil have some ideas as to what flowers, and fruits and seeds are structurally and morphologically.

So the writer would reverse the order, beginning with page 386 and then after covering the subject as far as page 411, he would go back to pages 257–385 and take up much what is outlined there. In his opinion, which is confirmed by a good many years of experience with classes of beginners, and observation of high school pupils in botany, such a sequence is better for the pupil, and less likely to lead to confusion; and he so advises all teachers in high schools within his "sphere of influence."

And now, after saying all this about the mere matter of sequence, the writer here gives it as his opinion that Professor Ganong has made a most valuable addition to the literature of botanical pedagogy, and his book ought to be read by every school teacher, and while we are at it we might as well include college and university teachers also.

CHARLES E. BESSEY
THE UNIVERSITY OF NEBRASKA

SPECIAL ARTICLES

A FURTHER STATISTICAL STUDY OF AMERICAN MEN OF SCIENCE

II

In addition to the 269 men added to the thousand, whose origin, education, distribution, ages and standing have been considered, there were 731 men on the list of 1903 who retained places on the list of 1910. Some of them maintained about the same places as before, some improved their positions and some dropped down to lower places on the list. The number of places that each individual moved up or down is known. A gain or loss of a hundred places at the bottom of the list would not be significant, as the probable error of the change would be about 100 $\times \sqrt{2}$. A gain of a hundred places at the top of the list, where the probable error is under twenty places, would represent a certain and important advance in the estimation in which the work of the individual is held. The value of gains or losses in different points in the series is inversely as the probable error corrected by the range, and it is thus possible to represent the gains or losses of individuals wherever they occur in comparable figures. If a gain of one place in the last five hundred is taken as the unit, a gain of one place in the upper hundreds would be approximately as follows: V. = 1.5; IV. = 2; III. = 3; II. = 6, and I. = 10. Dividing further the first hundred, a gain in the lower fifty equals 8, and gains in the two upper twenty-fives, respectively, equal 10 and 14. On such a scale the gain or loss of each individual has been assigned. It is a truly dramatic figure expressing with almost brutal conciseness the efforts, the successes and the failures of seven years of a man's life.

The gains and losses of those on the list of 1903, apart from the 68 who died or removed from the country, are shown in the accompanying curve (Fig. 1).

It is a tolerably symmetric surface of distribution, in view of the limited number of cases and the complicated conditions. 357 men improved their positions and 575 lost ground, of which latter 201 dropped out of the thousand. The average loss was 113 places, these being places in the lower five hundred, equal to one tenth as many places in the first hundred. Apart from this average change in one direction, or constant error, there was an average change of position, or variable error, which referred to the age groups in 305 places.

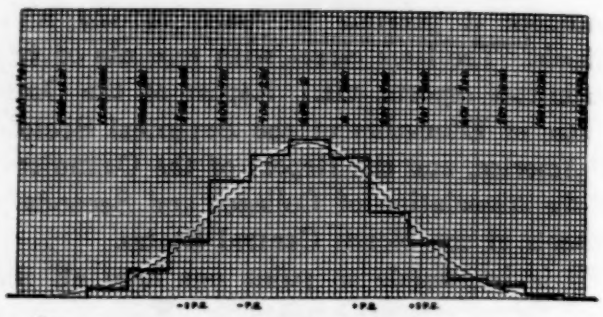

Fig. 1.

This variable error is due to two factors—the chance error of arrangement (say 141) and the real change in the position of the men—and is equal to the square root of the sum of their squares. The real variable error is consequently 270. Men on the list thus lost on the average 113 places, and from this average there was a loss or gain of position, which on the average amounted to 270 places.

The removals from the list would tend to give higher positions to those remaining on it. If the 68 removals were equally distributed over the list, they would allow on the average an advance of 34 places to each man, or, weighting the places, an advance of 73 places of the value of those in the lower five hundred. Instead of such an advance, there was an average loss of 113 places and consequently a total average loss of 186 places. With a gross variable error of 305 places there might be expected to be dropped from the list about 155 men, apart from any negative constant error or any positive advance due to the deaths.

In a stationary scientific population it might be reasonable to assume that the losses by death would be filled by those below the thousand and that those in the thousand would maintain the same or an improved average

position, while only so many would be dropped from the thousand as are accounted for by the variable error. In an increasing scientific population, however, the standard of the thousand would become higher. If there were an increase of ten per cent. in the number of scientific men in the course of seven years, then there should be 110 of the same rank as the first hundred in the thousand of 1903 and 1,100 of the same rank as the thousand. A man in the lower part of the list who maintained his absolute position would lose nearly a hundred places in relative position, and, apart from the variable error of position, 91 of those in the thousand would drop to the eleventh hundred. As a matter of fact the average loss in position was 113 places, and the number dropped from the list was 46 in excess of those accounted for by the variable error. According to this argument, the increase in the number of scientific men of standing in seven years would be from 5 to 11 per cent., or about one half the increase of the population. There has certainly been no increase in the number of scientific men of standing commensurate with the increase in the instructors, students and endowments of our universities, with the larger appropriations for scientific work under the government, or with the new foundations for research.

Table V. gives the gains and losses of the thousand scientific men of the list of 1903 (apart from the 68 who died or removed from the country) in reference to their standing and their present ages. It thus appears that in each hundred of the thousand the men were more likely to lose in position than to gain, but that those in the first hundred lost the least and those in the upper hundreds lost less than the average. Of those in the first hundred 44 gained in position and 46 lost, the average loss being 53 places. They were not subject to the competition of an increasing population, and only seven men not on the list of 1903 attained places among the second hundred. It thus appears that even men of established reputation do not maintain their positions, they do not advance as they grow older, and death removes more eminent men whose places they might fill. The losses tend to increase as the men are of lower rank, but the differences are not considerable. The variable error being 305 places, the probable error of the figures given in the table is rather large.

In the case of age it is clear that the younger men in the thousand are likely to improve their positions, while the older men are likely to fall back. The nine men now under thirty-five have, on the average, gained 364 places and the 77 now between thirty-five and thirty-nine have, on the average, gained 144 places. Of those under forty, 54 gained and 32 lost. In the next five-year period men are about as likely to lose as to gain, whereas older men are likely to lose. There appears to be a plateau between the ages of those now between fifty-five and seventy-four; in the

TABLE V. GAINS AND LOSSES IN REFERENCE TO POSITION AND TO AGE

Position.	1–100.	101–200.	201–300.	301–400.	401–500.	501–600.	601–700.	701–800.	801–900.	901–1000		Totl.
Number	90	91	95	92	91	92	97	93	94	97	—	932
No. gained	44	40	37	34	35	28	40	31	26	42	—	357
No. lost	46	51	58	58	56	64	57	62	68	55	—	575
Constant error	−53.3	−93.9	−99.4	−64.5	−115.8	−160.8	−95.3	−165.0	−182.9	−89.1		
Age.	30–34.	35–39.	40–44.	45–49.	50–54.	55–59.	60–64.	65–69.	70–74.	75–85.	Not Kn'n.	Total
Total number	9	77	187	194	155	104	85	52	38	24	7	932
No. gained	6	48	94	79	60	23	17	14	11	1	4	357
No. lost	3	29	93	115	95	81	68	38	27	23	3	575
Constant error	+364	+ 144	+29	−103	−134	−276	−268	−262	−227	−438		
Variable error	*485*	*328*	*366*	*284*	*308*	*285*	*252*	*299*	*258*	*185*		

course of the seven preceding years they have about the same record. They tend to lose about 250 places or about twice the average of all the men on the list. The 24 men who seven years ago were sixty-eight years of age or older have nearly all lost in position. It is not likely that any one of them has done anything to lower his scientific reputation; but men of the younger generation have accomplished work of greater importance, or the work of older men is forgotten because it is less contemporary. It thus appears that under existing conditions in this country, scientific men are likely in the course of seven years to lose about 100 places. Men who have obtained recognition among the thousand are likely to gain if under forty; if between forty and fifty they are likely to lose, and if over fifty-five they are likely to lose more than the average.[5a]

The average age of the thousand scientific men on the list of 1910 is 48.12 years. The age distribution is as follows:

Age	Number
25–29	6
30–34	54
35–39	155
40–44	214
45–49	176
50–54	137
55–59	82
60–64	68
65–69	40
70–74	33
75–79	13
80–84	7
Unknown	15

In Table VI. is given the average age of the men in the ten groups of one hundred making up the thousand for the lists of 1903 and 1910.[6] The probable errors of the averages are less than one year. It thus appears that the more eminent scientific men are likely to be older; but the differences are small apart from the first hundred, who in 1903 were 5.1 years older than the average, and in 1910 6.7 years older. Scientific men do not become more eminent as they grow older unless they have obtained a good position at a comparatively early age.

The men on the list of 1910 are, on the average, three years older than those on the list of 1903. An increase in age would be

TABLE VI. AVERAGE AGE ACCORDING TO POSITION IN 1903 AND 1910

	Average Age.			Average Age.	
	1903.	1910.		1903.	1910.
I.	50.12	54.78	VI.	43.70	46.40
II.	49.76	48.94	VII.	41.97	45.60
III.	47.04	48.34	VIII.	42.36	47.82
IV.	45.38	48.62	IX.	43.50	45.94
V.	44.09	48.50	X.	42.32	46.14
			Average	45.02	48.11

TABLE VII. AGES AT WHICH THE BACHELOR'S DEGREE AND THE DOCTORATE OF PHILOSOPHY WERE RECEIVED ACCORDING TO SCIENCE AND TO POSITION IN THE THOUSAND

	Bachelor.		Ph. D.	
	No.	Age.	No.	Age.
Mathematics	67	21.9	64	28.4
Physics	112	22.1	87	28.6
Chemistry	132	21.6	114	26.7
Astronomy	34	21.6	14	29.3
Geology	85	22.8	43	28.5
Botany	83	23.7	56	30.5
Zoology	117	22.6	96	28.8
Physiology	29	21.7	19	26.7
Anatomy	15	23.7	2	30.5
Pathology	30	20.7	6	27.2
Anthropology	8	22.0	6	27.5
Psychology	46	21.7	37	27.6
No. or average	758	22.2	544	28.4
I.	74	21.6	57	26.9
II.	77	21.9	52	27.3
III.	80	22.3	56	27.7
IV.	74	22.2	52	27.5
V.	74	22.2	53	28.2
VI.	74	22.0	63	29.3
VII.	79	22.4	52	28.6
VIII.	76	22.2	58	28.8
IX.	74	22.8	49	29.3
X.	76	22.8	52	29.1
No. or average	758	22.2	544	28.4

[5a] The coefficient of correlation between age and gain in position is — 31.7. It is, however, doubtful whether the Galton-Pearson method can be used to advantage in such cases.

[6] The list for 1903 used for ages consisted of the 1,000 scientific men who stood first before the adjustments had been made to secure a fixed number in each science.

expected, as we have to do with a youthful and increasing scientific population. Some part of the increase in age is probably caused by the long period of education now likely to precede productive scientific work, but it is not easy to analyze the factors. In so far as the increased age is due to higher standards through increasing competition, it is gratifying; in so far as it is due to the postponement of scientific productivity, it is unfortunate.

For the list of 1903 data have been compiled in regard to the ages at which academic degrees were received. The average age at which 758 men received the bachelor's degree was 22.2 years, and the average age at which 544 men received the doctorate of philosophy or science was 28.4 years. The corresponding median ages were 21.8 and 26.9 years. Table VII. shows the details in reference to the different sciences and the ten groups of a hundred composing the thousand. The age differences are small, but men have received the bachelor's degree at an earlier age who have become pathologists than those who have become anatomists or botanists. The chemists have received the doctor's degree at the earliest age and the anatomists and botanists at the latest. The mathematicians have received the doctorate at exactly the average age, not earlier, as the writer would have anticipated.

In the different sciences there are decided differences in the proportion of those who have received academic degrees. Only half the pathologists have the bachelor's degree and one twelfth the doctorate of philosophy, their education having been in the medical school. Of 50 psychologists 46 hold the bachelor's and 37 the doctor's degree. The doctor's degree is held by nearly two thirds of the zoologists, while it is held by less than half the geologists and less than a third of the astronomers.

There is a small but definite correlation between standing and the age at which the men received their degrees—the more eminent the men the earlier the age. Those in the first hundred have received both the bachelor's and the doctor's degree at the earliest age, the former 0.6 and the latter 1.5 years below the average. The second hundred are the next youngest, the ages for the two degrees being 0.3 and 1.1 below the average. Those in the lower two hundred were 0.6 year older than the average in receiving the first degree and 0.8 year older in the case of the second degree. There is no correlation between standing and the possession of one or the other of the degrees.

Our thousand leading men of science are occupied as shown in Table VIII. 738.5[1] are engaged in teaching, or have been so engaged, and now fill administrative educational positions or have retired from active service. Nearly three quarters of our scientific men earn their livings by teaching, and a large proportion of the others have done so. In this country, as in Germany, the advancement of science depends mainly on those who hold chairs in our colleges and universities. Some ten per cent. of our scientific men are engaged in work for the government, among whom the geologists predominate. Only six per cent. earn their livings by direct applications of science. Apart from one actuary, this work is in applied chemistry, engineering and mining. There is no one who earns his living by applications of the natural sciences. Research institutions, nearly all of recent foundation, employ 35 men. There are 24 connected with museums, academies and libraries and 12 with botanical gardens. Only eleven among the thousand may be classed as amateurs, and these include several married women who should perhaps be given a separate place. This contrasts with Great Britain, where Darwin, Huggins, Rayleigh and many other great scientific men, not needing to earn their livings, have devoted their lives to scientific research. Only three physicians not connected with medical schools have done scientific work of consequence. One architect, one artist, one editor and one missionary appear on the list, but no lawyer or man of business. It seems that in this country the time has gone by when science can be advanced by any except by those engaged in certain definite profes-

[1] The decimal here and elsewhere refers to a man who gives part of his time to teaching or to the institution to which he is credited.

TABLE VIII. OCCUPATION OF THE THOUSAND MEN OF SCIENCE ACCORDING TO SCIENCE AND TO POSITION

	Teaching.	Government Work.	Applied Science.	Research Institutions.	Museums and Academies.	Botanical and Zoological Gardens.	Amateurs.	State Work.	Physicians.	Architects.	Artists.	Editors.	Missionaries.	
Mathematics	77	1	1									1		80
Physics	104	18	22	6										150
Chemistry	126.5	12	28	8.5										175
Astronomy	38	5		4			3							50
Geology	52.5	30.5	8	1	2		1	5						100
Botany	66	12		6	2.5	12.5	1							100
Zoology	112.5	14		3	15.5	1	2				1		1	150
Physiology	37	1		2										40
Anatomy	21			2	1		1							25
Pathology	51	4		3					2					60
Anthropology	7.5	8			3.5		1							20
Psychology	45.5	0.5					2		1	1				50
	738.5	**106**	**59**	**35.5**	**24.5**	**13.5**	**11**	**5**	**3**	**1**	**1**	**1**	**1**	**1000**
1– 100	79	7	1	6	3	2	2	?	?	?	?	?	?	100
101– 200	78	12	2	4	1		1							100
201– 300	80.5	12	3	2	1.5									100
301– 400	67	18	8	1	2	3								100
401– 500	69	11	5	4	4	2	1							100
501– 600	78	9	7		2	3								100
601– 700	67.5	11	5	8	3	2.5	2							100
701– 800	72	12	9	3	3									100
801– 900	69.5	6	11	4.5	3	1	4							100
901–1000	78	8	8	3	2		1							100
	738.5	**106**	**59**	**35.5**	**24.5**	**13.5**	**11**							**1000**

sions, while these professions require men, with a few exceptions, to earn their livings by teaching or by applied science.

The standing of those in the different professions does not show a considerable difference. There are in the upper three hundred relatively more men engaged in teaching and in the research institutions, and fewer in applied science, but the differences are scarcely significant, except that those engaged in applied science are of somewhat lower standing. Those in the government service and the officers and curators of museums and botanical gardens are of average standing.

There were 19 women on the list of 1903. None of them died but seven were not placed on the list of 1910. This is a somewhat larger proportion than in the case of the men, but the figures are too small to have significance. Six women found a place for the first time on the list of 1910, the highest being in the fifth hundred. It thus appears that women have not improved their position in science in the course of seven years, and it is not an important one, only 18 women among 982 men, with none in the first hundred, two in the second, two in the third and three in the fourth. There are now nearly as many women as men who receive a college degree; they have on the average more leisure; there are four times as many women as men engaged in teaching. There does not appear to be any social prejudice against women engaging in scientific work, and it is difficult to avoid the conclusion that there is an innate sexual disqualification. Women seem not to have done appreciably better in this country than in other countries and periods in which their failure might be attributed to lack of opportunity. But it is possible that the lack of encouragement and sympathy is greater than appears on the surface, and that in the future women may be able to do their share for the advancement of science.

TABLE IX. DISTRIBUTION OF THE FIRST AND SECOND THOUSANDS

	First Thousand.			Second Thousand.	
	No.	Gain or Loss.	Per Million 1900.	No.	Per Million 1900.
North Atlantic.					
Maine	3	− 1	14.3	5	7.2
New Hampshire	8	0	19.4	8	19.4
Vermont	1	− 1	2.9	6	17.4
Massachusetts	165	+21	58.7	103	36.7
Rhode Island	9	+ 1	20.9	11	25.7
Connecticut	50	+ 7	55.0	32	35.2
New York	183	− 9	25 1	166	22.8
New Jersey	26	− 9	13.2	29	15.3
Pennsylvania	60	− 5	9.5	69	10.9
South Atlantic.					
Delaware	0	− 1	0	4	21.7
Maryland	39	− 8	32.8	30	25.2
Dist. of Columbia	109	−10	391.0	111	399.2
Virginia	10	0	5.4	14	7.5
West Virginia	2	− 1	2.0	3	3.1
North Carolina	7	+ 1	3.7	7	3.7
South Carolina	0	0	0	3	2.2
Georgia	0	− 1	0	1	0.4
Florida	0	0	0	3	5.7
South Central.					
Kentucky	0	− 3	0	5	2.3
Tennessee	1	− 2	0.5	8	3.9
Alabama	2	0	1.1	2	1.1
Mississippi	0	0	0	1	0.7
Louisiana	4	+ 3	2.9	1	0.7
Texas	4	− 3	1.3	10	3.2
Oklahoma	0	0	0	2	5.0
Arkansas	0	0	0	1	0.7
North Central.					
Ohio	34	0	8.2	39	9.3
Indiana	11	− 1	4.4	21	8.3
Illinois	77	+14	15.9	87	18.0
Michigan	25	− 2	10.3	31	12.8
Wisconsin	36	+13	17.4	14	6.7
Minnesota	13	0	7.4	20	11.4
Iowa	6	− 1	2.7	15	6.7
Missouri	24	+ 3	7.7	19	6.1
North Dakota	1	− 1	3.1	4	12.5
South Dakota	1	− 1	2.4	2	4.9
Kansas	5	0	3.4	14	9.5
Nebraska	6	− 3	5.6	11	10.3
Western.					
Montana	0	− 2	0	3	12.3
Wyoming	0	− 1	0	1	10.9
Colorado	9	+ 1	16.6	13	24.1
New Mexico	0	− 2	0	1	5.1
Arizona	4	+ 2	34.2	2	16.4
Utah	0	0	0	5	18.1
Nevada	0	0	0	1	21.4
Idaho	0	0	0	2	12.4
Washington	0	0	0	6	11.6
Oregon	1	+ 1	2.4	1	2.4
California	50	− 3	33.6	38	25.6
Hawaii	2	+ 2	12.9	1	6.5
Porto Rico	0	0	—	1	—
Panama	1	+ 1	—	0	—
Philippines	4	+ 1	—	8	—
Canada	1	− 1	—	0	—
Mexico	0	0	—	1	—
Cuba	1	0			
Brazil	1	0	—	0	—
Argentine	2	+ 2	—	0	—
Peru	0	0	—	2	—
France	1	+ 1	—	0	—
Germany	0	0	—	1	—
Switzerland	1	+ 1	—	0	—
Turkey	0	0	—	1	—
Number	1000			1000	

Table IX. gives the distribution on January 1, 1910, of the thousand leading scientific men of the country and the gain or loss of each state in a period of about four years. The distribution of the second thousand is also shown. In respect to the first thousand, the main facts have already been considered in connection with the men who have acquired or lost places in the group. This table shows in addition the changes which have occurred as the result of men removing from one state to another who have retained their places on the list. Massachusetts, as has been noted, gained 14 men owing to the fact that 43 of the new men reside in that state, while but 29 were lost to it through death or through dropping below the standard. In addition it has gained seven men, the excess of those having places on both lists who have moved into the state above those who have left it. Its total gain in scientific men of standing is consequently 21, and it has 58.7 of these scientific men per million of its population according to the census of 1900, as compared with 51.3 about four years ago. The increase in the number of scientific men is nearly 13 per cent. This is an honorable record. It is commonly assumed that Boston has yielded to New York City the position of literary center of the country, and if the facts were not known the same assumption would probably be

made in regard to science. As a matter of fact Boston has 126, New York 120 and Washington 110 of our leading scientific men. In comparison with population and with wealth, Boston is far in advance of New York, though it is Cambridge and Harvard University which give Boston its preeminent position.

New York and Pennsylvania have in part retrieved the loss due to men dropping out of the first thousand by calling men of this rank from other states. Though they have lost, respectively, 22 and 12 through the failure of their men to maintain their positions, they have drawn an excess of 13 and 7 from other states, so that their total losses are 9 and 5. It appears that the immense wealth of these states has been but sparingly used to bring new men to them, whereas the conditions are such that those residing there are more likely to lose than to gain in scientific position. It may be unsafe to draw sweeping conclusions from such figures, but they certainly indicate that residence in these states is unfavorable to scientific productivity. It may perhaps be the case that the salaries are below the expensive standards of living and that opportunities for commercial and hack work are tempting, so that men are drawn away from research. The District of Columbia has lost nine men. Eleven have been removed by death, and this loss has not been made good by men improving their positions or going to reside in Washington. In view of the increasing appropriations made by the government for scientific work and the endowment of the Carnegie Institution this is not a favorable record.

Illinois and Wisconsin show the gains due to men who have improved their positions, there being no significant changes due to removals. The same is generally true in regard to the gains or losses in the other north central states and in the west and south. The numbers are too small to be as a rule significant. Missouri and Louisiana have each gained three men, Arizona two and Colorado one. Ohio and Minnesota are exactly stationary. Indiana, Michigan, Iowa, Texas and California have in each case lost from one to three men. The southern states (except Louisiana) have been losing even the few scientific men whom they had.

Table IX. shows also the distribution of the thousand scientific men standing below the first thousand. The men are not as well known and they can not be arranged as accurately in the order of merit. They were not independently selected from a larger group by the judges, but were those not assigned a place in the first thousand. The first five hundred were selected from the thousand with a tolerable degree of validity, but the second five hundred can only be regarded as representative of the scientific men who have done research work, but are not of the rank of the first fifteen hundred. The men are, however, arranged in the order of merit, and probable errors can be assigned to the positions as in the case of the first thousand. The number from each science is the same as in the case of the first thousand.

It is an honor to belong to this second group of a thousand men; they deserve well who have accomplished research work and have obtained recognition as scientific men. But those who are young have far greater promise than those who are older. All young men of ability must pass through the second thousand before they reach the first, though they are likely to escape notice in a period which may be short. The group is thus heterogenous, including those who may become our leading men of science and those who have attained a mediocre though creditable position beyond which they will not advance. The same conditions hold for the lower hundreds of the first thousand. In the preceding paper the scientific men were divided into two groups of 500 each, and no considerable differences were found in their origin or distribution. This appears to have been in part due to heterogeneous character of the second group. Thus Massachusetts had 74 men in the first five hundred and 70 in the second, while New York had in the two groups 93 and 99, respectively. But in the intervening period more men in Massachusetts than in New York have retained or improved their positions. It

thus appears that Dr. F. A. Woods[8] is correct in holding that Massachusetts has not only produced more scientific men, but also men of higher standing.

The second thousand includes those who have dropped down from the first thousand (201), to whom consideration has already been given. The others have been divided into those above and those below the median age (42 years), but the conditions are almost too complicated to admit of analysis, and it seems to be scarcely worthwhile to give the figures. In New York 43 are below and 68 above the median age; in Illinois 37 below and 28 above, and in California 9 below and 18 above. The excess of older men in New York may be attributed to its earlier development and to the fact that older men, especially in applied science, tend to reside in New York City. Chicago is of more recent origin and has called younger men to its universities. In Massachusetts and the District of Columbia there are about equal numbers below and above the median age. Older men reside in Boston and Washington, and younger men have been called to the institutions of learning in the former city and to the government service in the latter. The eight scientific men in the Philippines are all below the median age.

The men of the second thousand are more equally and widely distributed over the country than those of the first thousand. The regions and institutions which are the strongest in numbers tend to have also the larger share of men of the higher rank. Thus Massachusetts has 165 men of the first thousand and 103 men of the second thousand; Connecticut 50 of the first and 32 of the second. The educational institutions of these states have called and kept good men. They have relatively more in the first thousand than in the second, as they have relatively more in the first hundred than of lower rank. New York has a smaller preponderance of the better men. In the District of Columbia the scientific men are drawn equally from the first and second thousands. Thanks to the recent development of its great university, Wisconsin has 36 men in the first thousand and 14 in the second. The superior men are in the majority in Missouri, but the other north central states have fewer men of the first rank than of the second. California has 50 men of the first thousand and 38 of the second. In general the western and southern states which have but few scientific men have relatively more of the second thousand. It is of course important to have even men of this rank. There are advantages and disadvantages in concentrating the better men in a few regions and institutions. The standards of the men in both thousands are becoming higher, though more slowly than would be wished.

The distribution of our scientific men is almost entirely determined by educational and scientific institutions, including under the latter the government bureaus. Table X. shows the institutions with which three or more of those among our thousand leading men of science are connected, together with the gain or loss in a period of about four years. The table also gives the ratio of the number of leading scientific men in each institution to the total number of instructors, to the total number of students, to the value of buildings and grounds and to the current income. Harvard, Wisconsin, the Carnegie Institution, Illinois, Yale and Chicago have made the most notable gains. Columbia, California, the Geological Survey, the Smithsonian Institution and the Department of Agriculture have suffered the most severe losses. Four years ago Harvard had 66.5, Columbia 60 and Chicago 37 of our leading scientific men, as selected three years previously. After this short period it has resulted that Harvard has 31.5 more than Columbia and Chicago the same number. Such changes are only to a small degree due to the probable errors of the arrangements, though in the case of Columbia the fact that last time there were 11 and this time but two men in the last hundred may be attributed in part to the probable error and account in part for the loss of that university. There is also a different kind of chance variation due to the

[8] "American Men of Science and the Question of Heredity," SCIENCE, N. S., 31: 205–209, 1910.

date to which the census refers. Thus since January 1, Harvard has lost two of its greatest men, while the losses of Columbia occurred earlier and certain important positions were vacant at that time. It is, however, a fact not without significance that Columbia and California, in which faculty control is regarded by the administration as less important than executive efficiency, have suffered the most serious losses, whereas Harvard and Yale, where the methods of appointment and promotion are more democratic, show most gratifying advances. Yale has disproved the assertion that a faculty is not able to select its own members. The Smithsonian Institution and the government bureaus, which are somewhat autocratically controlled, show serious losses, but these should be in part at least attributed to the inadequate salaries. The gain of 50 per cent. in the Bureau of Standards shows that losses are not inevitable.

Wisconsin and Illinois are the state universities which have made the most notable progress. Wisconsin has moved ahead of Michigan and is nearly equal to the Johns Hopkins and Cornell. The gain of almost 200 per cent. at Illinois is in the main due to the departments of chemistry and mathematics, to the heads of which the university was so wise as to call men of high scientific standing. Michigan has a gain of 3.5, Missouri of two and Indiana of one. Minnesota and Kansas are exactly stationary. Ohio has a loss of one, Iowa and Texas of two and California of 8.5.

The Johns Hopkins has gained three men, which is satisfactory in view of its limited endowment and the high standards it has always maintained. The Massachusetts Institute of Technology has gained 5.5, Cornell 1.5, Pennsylvania 1, Princeton 2 and Stanford 5. We may hope for a considerable further advance at Princeton in the near future. It will be noted that in general the larger institutions have gained, and this relative gain represents a greater absolute gain as the standard of the thousand becomes continually higher with the increase of the numbers of scientific men.

Among universities with which fewer scientific men are connected, Western Reserve has gained four men and Brown, Missouri and Tulane have each gained 2, whereas Nebraska has lost 3 and Wesleyan, Syracuse, Northwestern, Cincinnati and Texas have each lost two. Bryn Mawr, Vassar and Wellesley have gained and Smith has lost. Small changes of this character are not necessarily significant, as they may be accounted for by the chance error of arrangement or the chance date to which the data refer. Still in each case the change is probably a real one and of importance when considered in relation to the total number of professors in the institution. The gain of a scientific man of standing is worth more to an institution than a building costing $100,000.

Table X. gives also the ratio of the number of scientific men of the thousand in each institution to the total number of instructors, to the total number of students, to the value of the buildings and grounds and to the income for current expenses, the figures being based on the report of the commissioner of education for 1909.[9] The institutions vary

[9] Unfortunately the figures in the report do not seem to be uniformly accurate. For example, the value of the buildings of Columbia University are reported by the commissioner of education at $2,238,800, and those of the U. S. Military Academy at $20,000,000, whereas the buildings on the Columbia campus have apparently cost much more than those at West Point. The treasurer gives the assessed value of the Columbia buildings (apart from Barnard College, Teachers College and the College of Pharmacy) as over $6,000,000. The commissioner of education reports the total receipts of Columbia University, exclusive of gifts for endowment, to have been $5,572,943, whereas the treasurer reports for the same year an income for the Columbia College corporation of $1,614,166. The correct figures have been substituted in the case of Columbia, but it is to be feared that other figures in the report are misleading. The writer considered using the figures collected by the Carnegie Foundation, but these also seem to be difficult to interpret. Thus Illinois is said to have an annual income (for running expenses) of $1,200,000 and to spend $491,675 on salaries of

greatly. One half of all the instructors at Clark are among our leading men of science, whereas in certain institutions there is but one in fifty. The institutions which stand the highest are Clark, the Johns Hopkins, Chicago, Stanford, Bryn Mawr, Harvard, Wesleyan, Case and Princeton. These institutions have at least one scientific man of standing among each ten instructors. It is of interest to note that the five institutions that have the best record are of comparatively recent establishment. They have given a relatively more prominent position to science than the older institutions and have selected better men. At certain other institutions the ratios are: Yale, 10.6; Michigan, 12.3; Wisconsin, 13.2; Columbia, 13.3; Cornell, 16.5; California, 21.3; Pennsylvania, 25.2. The institutions having more than forty instructors to one scientific man of standing are George Washington, Pittsburgh, Tufts, Tulane, Syracuse, Northwestern, Indiana and Cincinnati. These differences are truly remarkable and should be widely known in the interest of scientific education and the advancement of science. Institutions differ in the relative strengths of their departments, but it will be found that those which have men of distinction in the natural and exact sciences also have such men in other subjects. Students should certainly use every effort to attend institutions having large proportions of men of distinction among their instructors. It will be ordinarily the case that in such institutions the younger instructors are also of higher standing. Scientific men, especially those beginning their careers, should try to accept positions only where the higher standards obtain.

In general the institutions which have a large proportion of scientific men of distinction among their instructors will also have a large number in comparison with the student attendance. But institutions vary greatly in the number of students for each instructor—from 3.9 at the Johns Hopkins to 18.1 at

teachers, and Pennsylvania to have an annual income of $589,226, and to spend $433,311 on salaries.

TABLE X. THE NUMBER OF SCIENTIFIC MEN CONNECTED WITH INSTITUTIONS WHEN THERE ARE THREE OR MORE

	No.	Gain or Loss.	Ratio to Instr.	To Students.	To Buildings and Grounds.	To Income.
Harvard	79.5	+13.0	7.8	49.2	138,364	24,729
Chicago	47.5	+ 8.5	6.0	114.9	187,741	35,986
Columbia	48.0	−12.0	13.3	96.7	259,954	45,989
Yale	38.0	+11.5	10.6	90.3	——	34,142
Cornell	35.0	+ 1.5	16.5	113.9	122,966	41,106
Johns Hopkins	33.5	+ 3.0	5.6	21.8	186,095	10,121
Wisconsin	30.0	+12.0	13.2	150.7	126,104	50,499
Dept. Agric.	28.0	− 4.0	—	—	——	——
Geol. Surv.	25.5	− 6.5	—	—	——	——
Mass. Inst.	25.0	+ 5.5	10.1	58.5	53,480	20,859
Michigan	23.5	+ 3.5	12.3	200.8	87,649	57,539
Stanford	21.0	+ 5.0	6.9	80.3	333,810	39,571
Carnegie Inst.	19.0	+12.0	—	—	——	——
California	18.5	− 8.5	21.3	191.9	281,761	81,387
Pennsylvania	18.0	+ 1.0	25.2	229.0	——	56,368
Illinois	17.0	+11.0	29.2	251.9	111,971	99,647
Princeton	16.5	+ 2.0	9.8	79.7	——	24,964
Smithsonian	16.0	− 6.0	—	—	——	——
Bur. of Stan.	12.0	+ 4.0	—	—	——	——
Missouri	11.0	+ 2.0	14.7	259.4	157,591	54,870
Minnesota	10.0	0	20.1	264.9	387,008	133,348
Ohio State	9.0	− 1.0	22.1	281.7	323,889	85,784
New York	8.5	− 1.0	28.1	446.5	435,294	49,062
Amer. Museum.	7.5	− 0.5	—	—	——	——
Clark	8.0	+ 1.0	2.0	17.7	66,562	17,585
West. Reserve	8.0	+ 4.0	24.5	126.3	187,996	30,496
Bryn Mawr	8.0	+ 2.0	7.2	52.5	243,649	37,185
N. Y. Bot. Gar.	8.0	+ 2.0	—	—	——	——
Brown	7.0	+ 2.0	12.9	141.9	257,142	65,813
Indiana	7.0	+ 1.0	43.0	353.0	85,842	50,349
Virginia	7.0	0	10.4	112.0	306,714	36,194
Northwestern	7.0	− 2.0	44.6	319.3	——	134,191
Rockefeller Inst.	6.0	+ 3.0	—	—	——	——
North Carolina	6.0	+ 1.0	15.7	131.0	103,833	27,191
Nebraska	6.0	− 3.0	36.1	544.3	210,225	101,509
Dartmouth	5.5	− 0.5	15.4	224.1	345,454	55,338
Washington (St. Louis)	5.0	+ 1.0	27.4	211.6	——	113,408
Kansas	5.0	0	36.2	442.0	220,000	91,775
Iowa State	5.0	− 1.0	30.6	494.4	328,938	109,620
Syracuse	5.0	− 2.0	46.8	627.2	550.051	148,350
Case	4.0	+ 1.0	8.8	111.3	207,500	12,204
Field Museum	4.0	+ 1.0	—	—	——	——
Tufts	4.0	+ 1.0	54.2	279.5	——	54,501
Vassar	4.0	+ 1.0	25.3	254.5	616,421	145,015
Smith	4.0	− 1.0	29.2	393.0	329,875	90,212
Cincinnati	4.0	− 2.0	42.3	348.5	367,030	68,624
Wesleyan	4.0	− 2.0	8.5	80.5	220,616	25,613
Wistar Inst.	3.0	+ 3.0	—	—	——	——
Tulane	3.0	+ 2.0	52.0	365.6	601,297	54,967
Wellesley	3.0	+ 1.5	35.3	427.3	423,841	127,937
Conn. Sta.	3.0	+ 1.0	—	—	——	——
Pittsburgh	3.0	+ 1.0	61.0	414.3	309,844	122,529
Colorado Coll.	3.0	0	19.0	225.3	362,667	29,166
Gen. Elect. Co.	3.0	0	—	—	——	——
G. Washington	3.0	0	61.6	502.6	111,500	58,437
Worcester	3.0	0	16.7	162.6	——	——
Texas	3.0	− 2.0	28.6	611.0	340,234	110,691
U. S. Navy	3.0	− 4.0	—	—	——	——

Chicago.[10] For each scientific man among the thousand, the numbers of students are: Clark, 18; Johns Hopkins, 22; Harvard, 49; Bryn Mawr, 52; the Massachusetts Institute, 58; Princeton and Stanford, 80; Yale, 90; Columbia, 97. These are the institutions which have at least one scientific instructor of distinction for each hundred students. The institutions not having one such instructor for five hundred students are Syracuse, Texas, Nebraska and George Washington.

There are extraordinary differences or discrepancies in the relation between the value of the buildings and grounds of different institutions and their annual incomes for current expenses as given in the report of the commissioner of education. Some institutions, as Michigan and Illinois, are said to spend nearly as much annually on their educational work as the total value of their buildings and grounds, whereas others, as New York, Stanford and Tulane, are said to spend scarcely more than a tenth as much. Apparently but little reliance is to be placed on such figures. In so far as they are correct the Massachusetts Institute has one scientific man of standing for each fifty-three thousand dollars invested in buildings and grounds. The other institutions having at least one scientific man for each hundred thousand dollars so invested are Clark, Michigan and Indiana. The institutions having but one scientific man of standing for four hundred thousand dollars or more invested in buildings and grounds are Vassar, Tulane, Syracuse, New York and Wellesley. The Johns Hopkins supports one leading scientific man for each ten thousand dollars that it spends. The other institutions which have at least one scientific man for each twenty-five thousand dollars spent annually are Clark, the Massachusetts Institute, Harvard and Princeton. Vassar, Northwestern and Minnesota are the institutions that spend the most in proportion to the number of their scientific men.

Men who stand toward the upper end of the list are of far greater consequence than those toward the bottom. Here too Harvard shows its primacy and in unmistakable terms. Of our hundred leading men of science nineteen are at Harvard, as compared with nine at Chicago and seven at Columbia and the Johns Hopkins.[11] Of the second hundred Harvard has 10.5, Chicago 15, Columbia 6 and the Johns Hopkins 3.

It is not possible to estimate the value of a great scientific man in terms of other men. It may even be argued with plausibility that the progress of science depends exclusively on the few men of genius, while the mass of scientific men erect obstacles, and are only of use as a group which on occasion supplies the great man. But in a comparison of this kind we have in mind men such as Galileo, Newton, Laplace and Darwin. In the list of a thousand living American men of science, those in the lead are not incomparable with the others. As a matter of fact, we undertake to measure them by the salaries we pay. These are obviously imperfectly adjusted to merit, and there are kinds of merit other than scientific distinction. If, however, a university pays its more distinguished professors three times as much as its younger assistant professors, it estimates the one to be worth three times as much as the other. In the case of the salaries and earnings of psychologists, it appears that those in the first hundred of the thousand earn about three times, and those in the second and third hundreds about twice as much as those in the lower half of the list. With numerous individual exceptions —some men of high standing even paying for the privilege of doing scientific work, while some men of medium standing may receive comparatively large salaries[12]—we find that

[10] These remarkable differences are confirmed by the report from the Carnegie Foundation, which gives the ratios as 3.7 and 17.4.

[11] The membership of the National Academy of Sciences corresponds closely with these figures—18 at Harvard, 9 at Chicago, 8 at Columbia and 7 at the Johns Hopkins.

[12] It is scarcely necessary to point out again the failure of our competitive system to reward scientific research, but it may be illustrated by an example. Lord Kelvin made a large fortune by his inventions and engineering advice; he earned a modest salary as professor at Glasgow; he was paid nothing for his great contributions

the salaries increase with distinction and roughly measure it, placing it about three times as high in the upper hundred as in the lower third of the list. It is also the case that the range of merit in the curve of distribution covered by the first hundred is almost exactly equal to the range covered by the second and third hundreds, and each of these is equal to the range covered by the remaining seven hundred.[13] It may not be possible to fix a zero point at which scientific merit begins, but it can plausibly be placed at a point below the first thousand, about equal to the range of merit covered by the other three groups. In this case the merit of those toward the bottom of each of the three groups in the thousand—the first hundred, the second and third hundreds, and the last seven hundred—would be as 3:2:1.

In order, therefore, to sum up in one figure the strength of a university or department, weights have been assigned to the men on this basis—a man in the lower four hundred being the unit, those in the other hundreds were assigned ratings as follows: VII. and VI. = 1.2; V. = 1.4; IV. = 1.6; III. = 1.9; II. = 2.2; and I. = 3. The first hundred were subdivided, the lower fifty being assigned 2.5, and the upper twenty-fives, respectively, 3 and 4. These ratings scarcely measure the real value of the men to society; they are nearly all paid less than they are worth, and the greater the performance of a man the more out of proportion is the payment for his services. They do, however, give with tolerable accuracy the value attached to men in our competitive system. A university can obtain a man of the first rank for from $5,000 to $7,500, or a man in the lower hundreds of the list for from $2,000 to $2,500. It is further the case that a moderate alteration in the weights adopted would not considerably alter the comparative results.

The scientific strength of our strongest institutions rated in the manner described, together with the gain or loss in a period of four years is shown in Table XI. Thus Harvard has a total scientific strength equivalent to 146 men in the lower part of the thousand and has made a gain equivalent to 16.3 such men in the course of about four years. In general the figures in this table correspond with those in the preceding table, but they tell us more. They take account not only of the number of men gained or lost, but also of the rank of these men and of the changes which have taken place through men improving their standing or failing to maintain it.

TABLE XI. THE SCIENTIFIC STRENGTH OF THE LEADING INSTITUTIONS

	Weighted Number.	Gain or Loss.
Harvard	146.0	+16.3
Chicago	94.6	+18.0
Columbia	79.3	−13.3
Hopkins	63.4	+ 4.2
Yale	61.7	+12.2
Cornell	57.6	+ 4.6
Wisconsin	49.0	+22.3
Geol. Survey	43.8	−12.2
Dept. Agric.	40.9	− 4.9
Mass. Inst.	37.7	+ 9.5
Michigan	37.1	− 3.5
California	32.4	− 5.0
Carnegie Inst	30.9	+19.4
Stanford	30.0	+ 4.8
Princeton	28.6	+ 7.5
Smithsonian Inst.	26.0	− 7.3
Illinois	25.0	+16.7
Pennsylvania	24.4	− 4.5
Bur. of Standards	18.9	+ 0.1
Clark	16.0	+ 2.0

If only the number of men is considered, Columbia and Chicago are equal and Harvard has made a larger gain than Chicago within the past four years. But Chicago has increased the number of men in the first hundred by two and in the second hundred by five. When we count up the total scientific strength, we find that Chicago is in advance of Columbia by the equivalent of 15.3 men and has gained more than Harvard by the equivalent of 1.7 men. Wisconsin and Illi-

to mathematical physics, though he might have earned large sums in the time devoted to these. His technical work was doubtless worth far more to society than he was paid for it, but it was worth less than his scientific research. In his three lines of work he was paid inversely as the value of his services.

[13] Cf. SCIENCE, N. S., **24**, p. 707, 1906.

nois also show larger gains than Harvard. While Yale has more scientific men in the thousand than the Johns Hopkins, and Stanford than California, the order of the institutions is in each case reversed when the effective strengths are calculated. The figures on the table appear to be significant and important, and it would be well if they could be brought to the attention of those responsible for the conduct of the institutions to which they relate.

Assuming the validity of the method of weighting used or, at all events, its relative validity for purposes of comparison, considerable reliance may be placed on the figures given in the table. The probable error of a man assigned a weight of one is greater owing to the break at the bottom of the thousand, and this is the largest factor in the probable error of the total. Men just coming within the thousand and men just falling below it are of almost equal merit, yet the former are counted and the latter are not. Still the probable error of a man assigned the weight of one is less than 0.5. When the errors are algebraically added the probable error of the sum increases as the square root of the number, and we may assume the probable errors of the figures given in the table to be not greater than one half of their square root. Thus in the case of Harvard, we may assume that the chances are even that its real strength is between 142 and 152 and its real gain between 14.3 and 18.3.

The scientific strength of an institution does not necessarily measure its total strength. Common observation would lead us to believe that the Johns Hopkins and Cornell are relatively stronger in the natural and exact sciences than Harvard and Yale. We may perhaps assume that the relative strength of a university in different departments tends to be proportional to the number of research degrees conferred. Data concerning these the writer has each year collected and analyzed.[14] Chicago has in the past thirteen years conferred exactly half its doctorates of philosophy in the exact and natural sciences. The percentages for the other universities which confer most of these degrees are: Cornell, 63; Johns Hopkins, 57; Yale and Pennsylvania, 43; Harvard and Columbia, 39. On this basis, the total strength of these universities, the unit as before being a man in the lower part of the thousand scientific men, is:

Harvard	374.4
Columbia	203.2
Chicago	188.2
Yale	140.7
Johns Hopkins	111.1
Cornell	91.9
Pennsylvania	56.7

These figures represent with tolerable accuracy the strength of each institution, so far as the subjects leading to the doctorate of philosophy are concerned. They do not, however, give adequate recognition to the professional schools, schools of law being practically ignored. Harvard has the strongest schools of law and medicine and has a school of theology, so its primacy would not be affected if these were fully accounted for. In its strength Harvard is nearly double Columbia and Chicago, which come close together. Each of these universities has nearly double the strength of the Johns Hopkins, which again has double the strength of Pennsylvania.

The figures at hand enable us to measure the strength of the scientific departments of the different universities. They are given in Table XII. for the ten strongest departments in each of the twelve sciences, together with the gain or loss within the period of four years. The institutions are arranged in the order of strength of the department, but when this is less than four the figures are omitted to avoid giving possible information as to the standing of individuals. The probable errors of the figures given in the table are somewhat less than one half their square root. Thus the strength of the department of mathematics at Chicago is equivalent to 16.8 men on the lower part of the list, and the chances are even that this figure is correct within two places. The

[14] Cf. for the last report Science, N. S., **32**: 231–238, August 19, 1910.

TABLE XII. THE TEN STRONGEST DEPARTMENTS IN EACH SCIENCE TOGETHER WITH THEIR GAIN OR LOSS IN A PERIOD OF ABOUT FOUR YEARS

Mathematics.			Physics.			Chemistry			Astronomy.		
Chicago...	16.8	+2.8	Harvard ...	19.6	+6.1	Mass. Tech.	19	+ 5.9	Chicago....	8.9	+1.9
Harvard...	14.2	+1	Bur. Stand.	15.9	+3.4	Yale	13.6	+ 4.4	California ..	8.7	−1.2
Columbia..	8.4	−1.3	Princeton ..	9.6	+3.9	Dept. Agr. .	12.8	+ 6.5	Harvard ...	7.9	+1.4
Yale.....	8.1	+1.2	Hopkins ...	9.4	+3.2	Harvard ...	11.3	− 2.5	Carnegie ...	6.8	+3.6
Illinois....	8	+8	Chicago....	9.3	+4.1	Hopkins ...	11	+ 3.6	Yale		
Princeton..	6.9	+2.7	Columbia ..	9.1	−8.9	Cornell	8.9	− 0.7	Columbia ..		
Cornell....	6.9	+0.1	Mass. Tech.	9	+2.8	Columbia ..	8.5	+ 1.4	U. S. Navy .		
Wisconsin..	6.7	+6.7	Cornell	8.3	−1.6	Illinois.....	8.3	+ 7 3	Wisconsin ..		
Mass. Tech.	4.1	+1.9	Carnegie ...	8.1	+4.9	Wisconsin ..	8.2	+ 1.8	Penna.		
Stanford...			Dept. Agr. .	6.1	−0.9	Chicago....	8.1	+ 2.4	Michigan...		
Geology.			**Botany.**			**Zoology.**			**Physiology.**		
Geol. Surv.	40.3	−5.3	Harvard ...	18.3	+ 3.2	Harvard ...	22	+3.3	Harvard ...	9.9	+0.1
Yale.....	9.6	+0.4	N. Y. Bot. .	13.5	0	Columbia ..	18.1	+1.4	Yale	7.1	+2.2
Harvard...	7.9	−1.2	Dept. Agr. .	13	−11.6	Chicago ...	13.8	+1.6	Hopkins ...	6.1	−1.1
Chicago...	7.4	−1.3	Chicago....	12.9	+ 2.3	Am.Museum	10.9	−2.6	Rockefeller .	4.9	+2.7
Wisconsin..	6.4	+2.2	Cornell	10	+ 2.8	Cornell	8.8	+2.3	Chicago ...	4.6	+1.4
Smithsonian	5.1	+1.3	Stanford ...	5.9	+ 2.2	Yale	8.3	+2.3	W. Reserve.	4.2	+4.2
Cornell....	4.9	−0.3	Wisconsin ..	5.2	+ 1.1	Stanford ...	7.6	+0.9	California ..	4	+1.8
Hopkins...	4.6	+1.5	Mo. Bot....	5 2	+ 1.4	Dept. Agr. .	7.6	+0.7	Wisconsin ..		
Stanford...			Carnegie ...	5.1	+ 5.1	Smithson...	6.5	−2.4	Cornell		
Columbia..			Hopkins ...			Princeton ..	5.6	+2	New York .		
Anatomy.			**Pathology.**			**Anthropology**			**Psychology.**		
Hopkins...	6.8	− 1.0	Harvard ...	16.5	+4.1	Smithson. ..	10.1	−3.3	Columbia ..	11	+ 1.4
Harvard...	4.9	− 0.3	Hopkins ...	11.5	+1	Columbia ..			Harvard ...	10.2	0
Michigan..			Chicago ...	7	+2	Harvard ...			Clark.....	5.2	+ 0.5
Wistar			Columbia ..	6.2	+0.2	Field Mus. .			Cornell	5	+ 0.5
Wisconsin..			Rockefeller .	6.1	+1.5	California ..			Chicago....	4.4	+ 2.8
Minnesota.			Michigan ..	6	−1.3	Am.Museum			Iowa		
Columbia..			Penna.	4.8	−0.3	Brooklyn...			Wellesley...		
Missouri...			New York..			Clark.....			Wisconsin ..		
Penna.			P. I. Bur.Sci.						Stanford ...		
Chicago...			Wisconsin..						Indiana		

gain in four years has been equivalent to 2.8 such men, and this figure is likely to be correct within 0.8. A gain of this kind may be due to the calling of new men or to the winning of higher places by the same men.

It should be kept in mind that the figures refer only to men included in the first thousand, and that these are graded for distinction in scientific work, ability in teaching and administration being given a subordinate place. A university may conceivably have a department consisting of men of moderate scientific standing, but of personal distinction and superior teaching ability. Some universities even have collegiate professors who are not supposed to permit research work to distract them from teaching and the personal oversight of students. The writer believes that such men belong to the past rather than to the present generation. Under existing conditions scientific men of ability and character will be investigators, and there is a high correlation between these traits and teaching skill. However, this is one of the numerous questions awaiting scientific solution.

Another factor not taken into account by the figures is the age of the men. As a matter of fact, this should not be considered in the present strength of an institution or department, for if a man of forty and a man of sixty have about the same position, they may be regarded as of about equal value for the present. There are drawbacks and advantages of both youth and age which nearly balance each other or regarding which we have at present no exact information. The writer would prefer the merits and faults of the younger men. However this may be, the departments or in-

stitutions having the younger men are in a better position as to the future.

In some cases the strength of the departments should be considered in relation to other factors. Thus, to take an example, the Bussey Institution, the Arnold Arboretum and the Museum of Comparative Zoology are parts of Harvard, whereas the New York Botanical Garden and the American Museum of Natural History are not parts of Columbia, though their heads and other officers may be professors at Columbia, and their facilities may be used for graduate study to the same extent as the Harvard institutes and museums. Or to take another example from the institution with which the writer is connected, the School of Pharmacy has but small educational connection with Columbia, but its professors would be added to the strength of its departments, whereas the Union Theological Seminary, now adjacent to Columbia, is closely affiliated with it educationally, but the professors would not be counted in its strength.

The geologists of the U. S. Geological Survey form the strongest group of men in the same science and under the same institution. The zoologists of Harvard stand next with about half the strength. There then follow in order the physicists of Harvard, the chemists of the Massachusetts Institute, the botanists of Harvard, the zoologists of Columbia, the mathematicians of Chicago, the pathologists of Harvard and the physicists of the Bureau of Standards. These are the departments which have a strength equivalent to fifteen or more men of standing.

Reviewing the sciences in order, it appears that in mathematics Chicago and Harvard are far in the lead, followed by Columbia, Yale and Illinois, the advance of the last institution being noteworthy here and in chemistry. In physics Harvard has double the strength of any other university and has gained largely. Columbia, which four years ago stood first, has lost more than any university in any department. In chemistry, the Massachusetts Institute of Technology stands clearly first, followed by Yale, Harvard and the Johns Hopkins. In astronomy, the great observatories—Yerkes, Lick and Harvard—give their universities precedence. The Mt. Wilson Observatory of the Carnegie Institution has entered this group, while the U. S. Naval Observatory has dropped from it. In geology the U. S. Survey overshadows the universities, among which Yale, Harvard, Chicago and Wisconsin are in the lead. In botany Harvard is far in advance, followed among universities by Chicago and Cornell. The New York Botanical Garden and the Department of Agriculture stand next to Harvard. The Department of Agriculture has, however, suffered severe losses within four years and is now as strong in chemistry as in botany. In zoology Harvard, Columbia and Chicago have by far the strongest departments. The American Museum of Natural History is twice as strong as the U. S. National Museum. In physiology, under which physiological chemistry and pharmacology are included, Harvard is followed by Yale and the Johns Hopkins. In anatomy the Johns Hopkins is followed by Harvard and Michigan. In pathology Harvard is followed by the Johns Hopkins, which precedes Chicago, Columbia and Michigan. The dependencies of the Smithsonian Institution employ nearly half the anthropologists of the country, but they have lost ground in recent years. Columbia, Harvard, California and Clark are the only universities with adequate departments. In psychology Columbia and Harvard have about double the strength of Clark, Cornell and Chicago.

Reviewing the same figures from the point of view of the institutions, the primacy of Harvard among our universities is unchallenged. It stands first in physics, botany, zoology, physiology and pathology; second in mathematics, geology, anatomy, anthropology and psychology, and third in chemistry and astronomy. In every science of the twelve, it is so nearly first that a small change would place it there. This is a remarkable record, and all honor should be given to the men responsible for it. The departments of Chicago and Columbia stand next to Harvard with about half its strength. Chicago stands first in mathematics and astronomy; second

in botany and third in geology, zoology and pathology. Columbia stands first in anthropology and psychology, second in zoology and third in mathematics. The departments at Chicago and Columbia are much more unequally developed than at Harvard. This, however, is not a disadvantage, as with limited resources it is probably desirable for a university to have certain strong departments rather than to have all of equal mediocrity. The departments of mathematics, geology, botany and zoology at Chicago, and of zoology, anthropology and psychology at Columbia are well developed, while in certain other sciences these universities stand at the bottom of the list or even fail to be included among the ten strongest departments. The Johns Hopkins stands first in anatomy, second in pathology and third in physics and in physiology. Yale stands first in geology (which includes mineralogy) and second in chemistry and physiology. The Massachusetts Institute of Technology stands first in chemistry.

The most important recent development of science has been the establishment of endowed institutions for research. The astronomical observatories, often officially but loosely connected with universities, are of earlier origin. Botanical gardens as centers of research also have a long history. There is every argument for similar institutions in each science, either as integral parts of universities, in affiliation with them or as independent institutions; and they are probably being established as rapidly as men can be found to do the work. In all our leading universities there are professors whose attention is devoted to advanced students and investigation, and their laboratories may be regarded as research institutions. Then there are specially endowed foundations, such as the Bussey Institution of Harvard or the new Crocker Cancer Research Fund of Columbia. The Wistar Institute of Biology, affiliated with Pennsylvania, is perhaps the most important institution of its class. Then we have independent institutions endowed for research, of which the most noteworthy are the Smithsonian Institution, the Carnegie Institution of Washington and the Rockefeller Institute for Medical Research. The Smithsonian is of special interest, owing to its early and peculiar foundation, but its endowment is not large according to modern standards, and its energies are mainly taken up in directing government bureaus. It does some publication, but very little research work. The Carnegie Institution with its endowment of $12,000,000 has been a disappointment to those who hoped that it would act the part of a special providence for science and scientific men. It is at present conducting research institutions in various places and publishing the work accomplished. It holds a good position in physics, astronomy, botany and zoology, having in all its departments a total strength of 30.9 men. It has an endowment about equal to the part of the Harvard endowment which may be allotted to the natural and exact sciences, which supports the equivalent of 146 men, who teach as well as carry forward research, so its money, though well spent, does not seem to go so far. A considerable part of the income has, however, been used for construction, equipment and publication. The Rockefeller Institute stands high in pathology and physiology and is continually improving its position. It has been placed under the direct control of scientific men and appears to justify this procedure. The Marine Biological Laboratory at Woods Hole is also conducted by scientific men and although without endowment is an important center for research. The zoologists working there in summer would have a strength greater than any department in any science, including the geologists of the national survey.

Bureaus under the national government stand first in geology and anthropology, second in physics and third in chemistry and botany. Excellent work is accomplished by these and other bureaus, but it is probable that foreign governments which spend far less on science have in their service men of greater distinction. There is a wide-spread belief that the government should only cultivate utilitarian science. In the opinion of the writer this is a mistaken point of view. Applied science can be left to commercial enterprise more

safely than research in pure science. The work which is of value to the whole nation and to the whole world, but has not immediate commercial value to any individual or group, is the kind of work which requires public support. If the man of genius exists he should be given opportunity to use his genius to the best advantage of all. It is extremely difficult to find the men most competent to do research work and to place them under the most favorable conditions, but if the immeasurable importance to society were realized, the difficulties would be solved. It is possible to imagine a national research university to which the ablest men should be drawn, some permanently and some temporarily, there to be given all possible facilities for their work, together with such honorable consideration and such salaries that science and scholarship would attain their due place and be made attractive to the fittest. One can even dream of an international research university to the support of which each nation would contribute a part of the cost of the armaments which it would tend to make useless.

The figures here given show the advantage of statistics over general impressions. The writer is perhaps as well informed as any one in regard to the distribution of scientific men, but some of the figures came as a surprise to him. He knew, or thought he knew, that Harvard had gained and Columbia had lost, but he had no idea of the extent of the change. He supposed that Chicago had lost and that Yale had stood about stationary, whereas both institutions show decided gains. He had no idea that Princeton had among its instructors a larger proportion of scientific men of standing than Columbia, or that the proportion in different universities varied from one half to one sixtieth. And so in many other cases he had wrong impressions, and others probably had wrong impressions of the same or other kinds. We are apt to form general conclusions from striking individual cases without regarding all the conditions. Prominent men lost by or called to an institution attract attention rather than the gradual improvement in the performances of a considerable body of men. The eminent man that an institution loses is not as a rule supplied by a new man, but a large loss in one case is made up by small advances in many cases.

It may be hoped that an exposition of the true conditions will be of service to science. From the point of view of abstract philosophy it may not matter whether a scientific advance is made in Russia or America, at one university or another. But abstract philosophy influences conduct less than concrete loyalties. A man who cares as much for other people's children as for his own is not likely to care greatly for any of them. The president of a leading university has recently urged the importance of increasing salaries, not in order to attract better men to the academic career or to enable them to do better work, but in order that his professors may not be paid less than those of a sister institution. Such a point of view may seem rather naïve, but it is sound human nature and should be appealed to for the improvement of the conditions under which scientific work is done. If the loyalty of alumni could be transferred from football to scholarship, there would result a decided gain to scholarship. The fact that each state wants its university to be as strong as its neighbor's is one of the most potent factors in the advance of the state universities.

Individual conduct is in the main automatic response to chance circumstance. But the organism and the circumstances and especially their interrelations may be altered. Organic life consists of adjustments brought about by the slow processes of nature. We have now reached the extraordinary position from which it is possible to make such adjustments for our own welfare by foresight and scientific method. The individual can prescribe a life of reason more readily than he can follow it. But an environment can be formed in which desirable conduct becomes a reflex response. Reason can have no better use than to select individuals and to arrange circumstances so that science may be advanced and applied for the good of all.

J. McKeen Cattell

Columbia University